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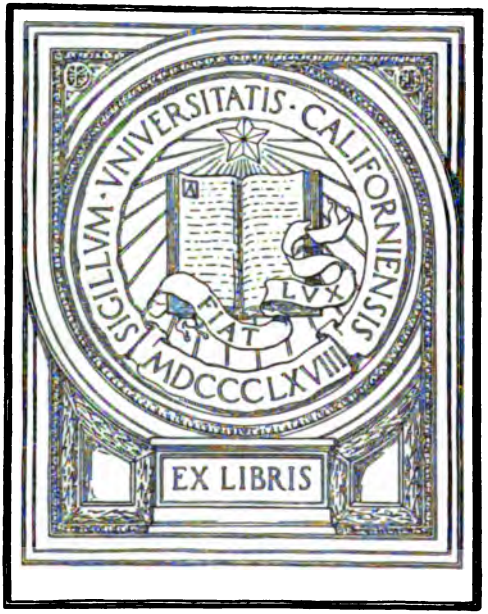

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No. 61. "Bromus Inermis." By F. L. Watrous, H. H. Griffin and J. E. Payne.

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No. 24. September 26 to October 2. By L. G. Carpenter.
No. 25. October 3 to October 9. By L. G. Carpenter.
No. 26. October 10 to October 16. By L. G. Carpenter.

REPORTS.

Annual Report for 1900.

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Bulletin 53. **March, 1900.**

The Agricultural Experiment Station

OF THE

Agricultural College of Colorado.

STRAWBERRIES.

—BY—

C. S. CRANDALL and C. H. POTTER.

PUBLISHED BY THE EXPERIMENT STATION,
Fort Collins, Colorado.
1900.

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The Agricultural Experiment Station,

FORT COLLINS, COLORADO.

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Strawberries.

A prominent feature of the work of the Horticultural Section of the Station has been the testing of new varieties of fruits. Of the small fruits grown the strawberry has received a due share of attention. Five years ago a report was made (Bulletin 29) covering the varieties tested up to that time. Since then many varieties have been added to the collection. Some of these possessed merit, others were of no value. It is the purpose of the present paper to bring together the notes of the last five years, and record the estimates of value placed upon the different varieties under trial. It should be understood, however, that it is not the intention to recommend varieties for general planting. Observations on a particular variety continued through successive seasons enables us to rate with accuracy its value for this locality, and for the conditions under which it is grown, but we fully appreciate the fact that under different conditions of soil and surroundings its behavior may be quite different. Our best varieties may prove unprofitable in other localities, and some that are of no value here may take rank among the best when grown under different conditions.

Varieties of strawberries as well as of other fruits are largely local in character, and the best for a particular locality must be determined by trial in that locality.

Cultural directions for strawberries were given in Bulletin 29, but as the edition is exhausted and as inquiries on various cultural points are frequently received, it is thought best to again touch briefly upon the more important features of strawberry management.

SOIL.

The strawberry can be made to grow on a great variety of soils, but it is easier to manage and reaches a better development on light loams than on heavy clays. A soil improperly drained, where water may stand for long periods, is entirely unsuited to this as well as to other fruits, and a very heavy clay is to be avoided if possible. A sandy loam of good fertility will produce earlier fruits than a heavy soil, it is easier to work, can be worked sooner after rains, and is in general more satisfactory. In many places along our streams there are broad stretches of bottom lands, sandy in texture and rich in humus, which, if well drained, are admirably adapted to strawberries.

It is best with any soil that it be cropped for one or two seasons before planting with strawberries, and preferably with crops that demand clean culture. It is of the first importance that the

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land be free from weeds and in loose, mellow condition. It is not good practice to plant on freshly turned sod; such land should be used one season for some hoed crop, which will leave it in good condition for strawberries.

For most soils deep plowing is to be recommended. There is an advantage in inducing the plants to root deeply. The deeply loosened soil holds more water, and the plants are less liable to injury during scarcity of water.

LOCATION.

The location for strawberries should be chosen with particular reference to irrigation. Land lying nearly level is to be preferred, but gentle slopes can be utilized by planting on contour lines, or in such manner that the furrows for irrigating have only sufficient fall to move the water slowly without washing the soil.

Great care should be taken to have an even surface. High points must be lowered and all depressions filled, so that the furrows will nowhere overflow and flood the rows. This can be best accomplished by the use of a simple box scraper made of plank. Generally it is a good plan to plow deeply in the fall. If the soil is heavy and inclined to be lumpy it may be best to harrow at once after plowing, but with lighter soils this is not necessary. In the spring plow again and harrow until the surface is finely pulverized.

FERTILIZERS.

Colorado soils are yet new, they have been cropped for only a few years, and the question of fertilizers has not yet demanded much attention.

Locally their need is being felt, and no doubt the time will come when the problem of the maintenance of soil fertility will be as important here as it is now in the older agricultural districts. The intelligent application of fertilizers calls for inquiry into all the conditions surrounding, not only the locality, but the particular piece of soil to which the application is to be made. It is essential to know something of the physical condition. Is it heavy clay, or light sand? Is it loam or gravel? Is it level or sloping? Is the substratum rock or impervious clay, or is it porous gravel? Is the soil deep or shallow? Well drained or inclined to hold the applied water? Knowledge on these points is gained by observation and examination, and they are all important, because they have a direct bearing upon the kind and quantity of fertilizer, and upon the time and manner of its application. As supplementary to a knowledge of the physical condition of the soil, it would be well to know something of its composition as shown by chemical analysis. While I do not believe chemical analysis can be taken as an index of the producing power of any particular soil, it is valuable in connection

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with a careful study of physical characters, in leading to the intelligent application of needed elements. Chemical values are potential, and while an analysis may accurately give the percentages of the various elements present, it can not tell with exactness what quantity of each essential element is in condition for immediate use as plant food. It is hardly possible to analyze the complicated processes that are taking place in the soil, converting complex inactive compounds into simpler forms ready for use in building up plant tissue. These processes are constantly in operation; they are less obvious and less known than many phenomena that are given prominence, but they are none the less important factors bearing upon the productiveness of soils.

An examination of several analyses of Colorado soils shows that they are rich in all of those elements classed among the inexhaustible soil ingredients, and that they also contain good percentages of the exhaustible elements which are so necessary to plant growth—nitrogen, phosphoric acid, and potash. It may be that much of the wealth of plant food shown by these analyses is not in an immediately available condition. If this be the case, what is the remedy? I may answer that the remedy may be sought in thorough cultivation and in an increase of humus by the addition of stable manure or by plowing under a soiling crop. Increase in the percentage of humus is important not only for its direct value as plant food, but for its influence on the physical condition of the soil, and for its action on other soil compounds. It makes clay soils less compact and increases the compactness of sandy soils; it increases the capillarity of the soil, thus bringing up to the roots food-laden water from below; it acts as a sponge to hold water in the soil, and it is a storehouse of nitrogen.

The strawberry is a gross feeder and to reach perfection demands a rich soil. I believe any soil intended for this plant will be benefited by a liberal application of stable manure, preferably that which has been rotted by composting. Our practice has been to apply a heavy dressing in the fall. This is plowed under and the surface harrowed down. Then water is applied until the ground is thoroughly soaked. In the spring we plow again and thoroughly pulverize the surface. The soil is then loose and moist at time of planting.

The principal objection to the use of fresh stable manure is that it is likely to carry with it many seeds of troublesome weeds. These seeds germinate or are in various ways killed during composting; then, too, the rotted manure is more readily incorporated with the soil and is more quickly available to the plants.

TIME TO PLANT.

In our practice at the Station we have had the best success from spring planting, and believe that in general it will be found

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best for Colorado conditions. In regions where the rainfall is greater and where cloudless days are less common, planting in August is practiced successfully by many, but the practice is by no means universal, and most growers who plant large areas prefer to plant in the spring.

Here there is often trouble in obtaining the desired number of well-rooted young plants early enough so that when transplanted they may become well established before the end of the growing season. The prevailing bright suns during August are trying to newly set plants, they are liable to wilt and be severely checked, even when care is used to apply water frequently. Stronger plants are obtainable in the spring, the ground is then moist and the air cool, they are checked but little and make a strong growth from the beginning.

If potted plants are used, the objection to August planting has not the same force, but the expense of potting is such that the practice is not to be commended, except possibly in a small way for the home garden.

METHODS OF PLANTING.

Two systems of planting strawberries are in use. The hill system, and the matted row system. In hill culture the rows may be two and one half or three feet apart, with plants twelve inches in the rows. No runners are allowed to form, the plants are kept distinct and are encouraged to make the strongest growth possible. The fruits produced are large, but the labor involved is considerable and the system is only suitable for small areas. The matted row system is in almost universal use for commercial plantations because the labor is less and the quantity of fruit greater. The plants are set from eighteen to twenty four inches apart in rows three and one half or four feet apart. To enable the plants to become well rooted, it is best to remove all runners until about the first of July, after which the runners may be allowed to root until a space eighteen inches wide is filled. The ideal matted row should have a width of eighteen inches with the plants distributed at about equal distances, five or six inches apart.

Some varieties produce runners so freely that it may be necessary to thin them somewhat to obtain the best results.

In transplanting, care should be taken that the roots do not become dry. It is a good plan to carry the plants in some vessel containing water and to distribute only as fast as they can be planted. In planting, a spade or dibble may be used. The roots should be spread out fan shaped and care taken to plant at the right depth. If planted too deep the crowns are liable to rot, and if not deep enough the roots will dry out, either being fatal to the plant. The earth should be well firmed about the roots and the surface left level.

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IRRIGATION.

An ample supply of water is essential to success with Strawberries. The plants need it in quantity throughout the season and particularly while maturing fruit. No garden plants more quickly suffer from lack of water, and none respond more readily when it is properly applied. It is our practice to make a shallow furrow close to each row of plants as soon as they are planted and run water at once, even though the soil be moist. It settles the earth about the roots, is an insurance against possible dryness, and gives the plants a vigorous start.

It may happen after an exceptionally open and dry winter that the soil in spring is very dry. We may then proceed in one of two ways; either irrigate first, and then, as soon as the ground can be worked, plow and prepare for planting, or the land may be prepared first and furrows made in which water can be run as the plants are being set. Do not try to set the plants in the furrow, in wet soil, but plant on the borders of the furrow and so plan that water may soon after reach them. The first plan is the best, but it sometimes happens that the ditches are not supplied with water early enough. In that case the ground must be made ready and the planting delayed until water is available.

Care should be taken in running water that it be confined to the furrows and not allowed to flood the rows. It is better to run small streams for long periods than to try to hasten matters by running too much water. To insure an even, constant flow, we make a lateral across the ends of the rows and supply the furrow for each row through a short piece of one inch pipe which is imbedded in the bank of the lateral. This is safer and easier to manage than breaking the bank of the lateral for each furrow, especially in soils that are inclined to wash.

As to frequency of irrigation, no definite rule can be given; it must be determined for each particular piece of ground. Some soils may require twice as many applications as others. Study the condition of the soil and the appearance of the plants, and govern the water supply by the indications there found. A thorough irrigation late in the fall, just before the ground freezes, is an excellent protection against a possible dry winter.

TILLAGE.

Thorough cultivation during the first season can not be too strongly urged. It conserves moisture, promotes the growth of plants, keeps the weeds down and is in every way beneficial. The after success of the plantation depends much upon the care given during the first months after planting. Cultivation should be continued until October, but after the runners commence forming new plants the space cultivated must be narrowed and the hoe used

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among the plants. Train the runners within the limits of the matted row, and when enough plants are formed cut those that encroach upon the space between rows.

There are differences of opinion regarding spring cultivation of an established bed. Some allow the mulch to remain, and hold that it is best not to disturb the ground until after fruiting. Others remove the mulch and cultivate the spaces until fruit begins to set. We find it best to remove the mulch, because it interferes with furrowing for irrigation. The spaces are cultivated after each irrigation, until near the fruiting season, then furrows are made so that water can be applied as needed, and the bed is not further disturbed until after the fruit is picked.

MULCHING.

Mulching is regarded as an essential to success. It protects the plants from the ill effects of freezing and thawing consequent to the extreme daily range of temperature common during February and March, and it retards blooming, thus diminishing the danger from spring frosts. A light cover answers every purpose. Heavy mulching is unnecessary, and if too heavy may injure the plants. Hay, straw, coarse manure, leaves, and cornstalks have all been used as mulches. Marsh or swamp hay, if free from weeds, makes an admirable mulch, but often is not obtainable. Wheat straw is better than oat straw, because usually threshed cleaner, but with either kind it is safer to use old rather than new. If the bed to be mulched is exposed to strong winds, it will be necessary to use brush or poles to prevent the straw blowing from the plants. Coarse manure is usually objectionable as a mulch, because of the weed seeds it is likely to contain.

SELECTION OF VARIETIES. POLLINATION.

Varieties of strawberries are many, and choice of kinds should be made with reference to the proposed disposition of the fruit. If for home use or home market, high flavor in connection with size and productiveness would govern the choice, but if for shipment to distant markets, firmness and long keeping would be of first importance, and must be given preference over other good qualities. No variety has all the desirable qualities equally developed, that is, the ideal, all-purpose berry has not yet been produced, and the best we can do is to choose the nearest approach to an ideal for our specific purpose.

Choice can not be made from reports upon a particular variety for some other locality, but must rest upon actual trial in your own locality, because, as we have already remarked, the same variety may behave very differently under unlike surroundings. For commercial growing it is best to confine the attention to few varieties, and be certain before planting largely that these varieties

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are adapted to your purpose and conditions. A succession to prolong the season may be desirable, but generally it will be found that the varieties intermediate in time of ripening prove most profitable. It is well enough to try novelties and new introductions in a small way, but never invest largely until their merits for your locality have been tested.

Choice must also be governed by blossom characters. Varieties are of two classes; those having perfect flowers, or in other words bearing both stamens and pistils, and those having pistillate flowers, or bearing pistils only. Some of our best varieties come under this latter class, and their ability to produce fruit depends entirely upon the proximity of other pollen producing varieties. Among the varieties bearing perfect flowers there is a wide difference as to pollen production; some have few and weak stamens and do not produce enough pollen to perfectly fertilize their own pistils; others have a normal complement of stamens with well filled anthers that have pollen to spare.

The strawberry is so commonly grown that it may seem unnecessary to dwell upon flower characters, but so many mistakes arising from inattention to these essentials have come under my immediate notice that the remarks upon the subject appear warranted.

If a pistillate variety has been decided upon, the question as to what proportion of the variety to be used as a pollenizer is necessary at once arises. On this point there is difference of opinion among growers. Some say four rows of the pistillate variety to one of the pollen producer, others would plant the two in equal quantity. I have found that two rows of the pollenizer alternated with four of the pistillate variety gave good results, but it may be as well to use them in equal proportions, particularly if both are desirable varieties.

A further point in reference to pollination may be touched upon here. Definite experiments upon apples, pears and plums have shown that some varieties are either wholly or in part self-sterile, that is, the pollen of a particular variety may be incapable of acting upon the pistils of that variety, or may act so slowly and imperfectly that the variety is unproductive. No definite experiments have been made upon strawberries, but observation leads to the suspicion that some varieties are, at least in some degree, self-sterile. If this be true, the obvious remedy is the same as recommended for the other fruits, namely, to mix varieties, not planting very large blocks of a single variety.

Fertilization in the strawberry is accomplished by insects, largely by bees, and if several varieties are near together the pollen is sure to be so distributed that the maximum of fruitfulness will result. Even if all varieties chosen for planting are strong pollen producers, we may infer from experiments upon other plants that

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there would be advantage in planting in alternate narrow blocks in order to facilitate interchange of pollen, for it has been shown that some plants, although perfectly self-fertile, derived advantage from the use of foreign pollen.

A further point to be considered in choosing varieties to be planted together, is the time of blooming. To be of advantage to the pistillate variety, the pollen producer must bloom at the same time, and the same would be true if aiming at mutual advantage from cross-fertilization between perfect flowered varieties.

PICKING THE FRUIT.

If the berries are to be shipped some distance, it is important that they be picked at just the right degree of ripeness, not too green nor yet fully ripe. This can only be learned by experience.

The calyx with a short piece of stem should always be left attached to the fruit. Growers should watch that careless pickers pay attention to this point, as it is essential to the keeping quality. Berries detached from the calyx should go with the over ripe fruit and buttons, and these should never be mixed with good marketable berries, because they take from the value of the whole. Careful grading requires extra labor, but it is profitable. The grower who attends to it can establish such a reputation for his fruit that it will be always in demand, even at advanced prices. It is the common fruit that is always over-abundant in the markets. Choice fruit is, as a rule, scarce and seldom seen on the market in quantity equal to the demand.

After the fruit is all picked, the spaces between the rows should be cultivated and the rows cleared of all weeds by hoeing. Cultivation should be continued until October, and water should be applied as often as is necessary to promote vigorous growth. Good care will induce the formation of fruiting crowns, upon which the success of the next crop depends.

DURATION OF PLANTATIONS.

In our experience two years is as long as a bed can be maintained with profit. The first year of fruiting will give the largest fruit, the second the greatest quantity, then vigor diminishes; the rows are too crowded to admit the growth of new plants, weeds multiply and are hard to control; for these reasons it is best to plow up the bed immediately after the removal of the second crop. A new bed should be set each year and an old one plowed up. Following the plowing of an old bed, the land should be used for one season for some other crop, or it is possible to meet good results by sowing with some soiling crop as soon as plowed, this to be turned under in the fall.

Many eastern growers find greatest profit in the practice of taking but one crop. The plants are set in August, fruited the next

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June and then turned under, but here in the west I believe it best to take two crops.

DESCRIPTION OF VARIETIES.

Annie Laura.—bisexual. Originated with J. F. Beaver, Montgomery county, Ohio.

The plants are of good size and vigor, forming sufficient runners and young plants. The leafstalks are short and stout, the leaflets are medium to large, broad, rather thin, coarsely toothed, pale to dark green in color. The bloom is not abundant, the flowers are very large, the petals are often over five in number, the stamens are large and well formed.

The berries are large, short, blunt-conic to oblate, scarlet, with glossy surface, slow in coloring at tips, inferior in quality and yield.

First bloom 19th to 22d, and the last bloom about the 28th of May. First ripe berries about June 19th, and the last picking July 12th.

With us this is a poor variety.

Aroma.—bisexual. Originated with E. W. Cruse, Leavenworth, Kansas.

The variety is a healthy, vigorous grower, of medium habit, setting runners very freely. The leaflets are large, broad-oval, closely notched, dark green in color. The trusses are medium to long, stout, upright, with but few branches, and these produce but scant bloom. The flowers are large, the petals are often over six in number, and the stamens are well formed. The calyx is sometimes slightly irregular.

The berries are medium to large, broad-conic, uniform scarlet, with flesh usually of the same color but sometimes pink, quality fair, seeds prominent, yield and firmness medium

First bloom May 19th, abundant bloom May 27th. First ripe berries June 20th, last picking July 7th.

The variety is not promising with us, but is reported to be very firm and of good quality at the Michigan Station.

Atlantic.—bisexual.

This variety is much like Seedling of Downing, a tall, vigorous grower, setting runners abundantly. The leafstalks are long and slender, the leaflets are medium to large, eliptic-oval. New foliage is pale, old foliage dark green, veins deeply impressed, trusses medium long, upright, rather slender, many-branched, bloom abundant, flowers medium size, petals usually five.

Berries large, short-conic, light red to scarlet in color but disposed to be green in spots, flesh white to light scarlet, seeds light, coloring in advance of the flesh and not set in deep pits, quality good, firm.

Blooms early. In 1896 it was in full bloom on May 12th and one half of the blossoms were killed by frost. Normally first bloom May 14th, abundant bloom May 23d. First ripe berry June 8–17th, last picking July 8th

The variety is unproductive and unworthy of further trial.

Barton.—pistillate. Originated in Kentucky from seed of Longfellow.

Plants medium to large, setting young plants freely, foliage ample, leaflets broad, deeply and sharply notched, inclined to be light green in color, trusses medium long, fairly stout, sometimes decumbent, bloom fairly abundant, flowers medium to small, usually with five small, pointed sepals and five nearly round petals, stamens none, pistil light green.

Berries medium to large, broad-conic with an acute point, scarlet color but often pale at tips, seeds prominent, quality and yield good.

First bloom May 12–14th, abundant bloom May 20th. First ripe fruits June 14th, last picking July 17th.

The variety is quite subject to frost injury, but promises to be medium to good in value. At the Georgia Station it ranks good in productiveness, medium in quality and firmness and poor in vigor.

Beder Wood.—bisexual. Originated with Mr. Beder Wood, of Moline, Ill., 1887.

This is an early, vigorous variety, producing plants in abundance. The leafstalks are stout and often over six inches in length, the leaflets long-ovate and

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dark green, trusses medium long, stocky, holding the blossoms as high as the foliage, bloom abundant, flowers medium size, regular, calyx rather small, with narrow, acute and often reflexed sepals. The stamens are numerous and well developed, pistils are pale in color.

Berries medium to large, uniform, nearly globular to short-oblong, frequently with a short neck, symmetrical, scarlet all over, seeds deeply set, flesh light colored, quality excellent, quite firm.

First bloom usually May 14-16th, abundant bloom May 19th. First ripe berry June 11th, full yield June 21st, last picking July 10th.

Although blooming early, it is but slightly injured by frost. We regard this as one of our most valuable varieties, especially desirable as a pollinizer for Warfield and other pistillates. It ranks well in value at the Kansas, Michigan, Montana and New York Stations, but is reported poor in quality, firmness and vigor at the Georgia Station.

Belle of LaCrosse.—bisexual. Originated with M. T. Crawford, Ohio.

This is a strong and vigorous grower, blooming freely but not setting many plants. It is well adapted to hill culture. The plants are large with broad crowns, leaflets medium to large, light to medium green, leafstalks medium to long, stout, trusses medium long, stout, upright, producing many blossoms and berries, flowers small to medium, petals usually five but often with an incomplete and undeveloped inner circle.

Berries medium size, conic, pointed, light scarlet shaded with crimson, flesh scarlet, seeds deeply set in irregular pits, quality good, acid, firm, yield abundant.

First bloom May 12–17th, abundant bloom May 24th. First ripe berry June 13–14th, first picking July 1st, good picking July 7th, last picking July 15th.

This variety is a late bloomer, but little injured by frost and is valuable with us. It is regarded valuable at the Michigan Station.

Bessie.—pistillate.

Plants medium to large, vigorous, light to dark green in color, foliage healthy, leafstalks erect, leaflets medium to large, long-ovate, trusses long, bloom scant, flowers medium size, petals five, stamens none.

Berries small to medium, conic, hull with difficulty, color deep red including flesh, firm.

First bloom the 17th, abundant bloom the 28th of May. First ripe fruit June 11th, first picking June 13th, last July 2d.

An excellent variety in growth and vigor but too unproductive with us to be of value. It is reported fairly vigorous, productive and of good quality and firmness at the Michigan Station.

Beverly.—bisexual. Originated with Benj. M. Smith, Beverly, Mass.

This is a second early sort, ripening with Warfield. It is a vigorous grower of medium habit, leaflets dark green in color, medium to large, broad, serrations deep, acute and usually overlapping, trusses long, upright, bloom abundant, flowers medium size, petals five, symmetrical, sometimes with a defective inner circle, stamens rather small, numerous and well developed, pistils pale green.

Berries medium size, globular to conic, seeds deeply set, surface rough, crimson, a little tardy in coloring at tips, quality good, acid, yield fair to good.

First bloom 12–18th, abundant bloom 24th of May. First ripe berries June 15–19th, first picking June 20th, best June 27th, last July 10th.

Variety of medium value with us and so reported from the Georgia and Michigan Stations.

Bisel.—pistillate.

Plants vigorous, medium in size, leaflets rather small, broad, dark green, trusses large, stout, bloom sufficient.

Berries small, conic with sharp apex, crimson, tip lighter, core slightly cartilaginous, yield only fair.

First bloom May 19th, abundant bloom May 24th. First ripe fruits June 19th, last picking July 2d.

So far the variety has done poorly with us. It is reported very favorably from the Montana Station but much less so from Georgia.

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Boynton.—pistillate. Originated in N. Y., probably a cross between Crescent and Sharpless.

While ranking as a pistillate it is apparently capable of self fertilization. It is a vigorous variety, forms plants abundantly, leafstalks medium to long, slender, leaflets medium size, oblong, deeply and sharply toothed, medium to dark green, trusses medium to long, ascending, branches short, bloom abundant, flowers small to medium, petals usually five, round but sometimes pointed, not imbricate, stamens more developed than with most pistillate varieties but still rudimentary.

The berries are much of the Crescent type and character, medium size, short-conic, scarlet, flesh light, core somewhat cartilaginous, quality good, acid, flesh firm, yield good.

First bloom May 12–15th, full bloom May 20th. First ripe fruit June 10th, first picking June 13th, full picking June 26th, last picking July 13th.

The chief fault of this variety is that the berries become very small towards the close of the season. Although inclined to be soft, it is reported very favorably from the Kansas and the Minnesota Stations. At the latter Station it does best in hill culture.

Brandywine.—bisexual. Originated in Eastern Pennsylvania. Supposed to be a cross between Glendale and Cumberland.

The plant is of rather low habit, forming young plants abundantly. The leafstalks are short and stout, the leaflets large and broad, dark green in color, trusses medium length, stout, bloom production medium, anthers numerous, large and well formed.

Berries large, broad-conic, crimson, flesh ditto, slightly cartilaginous.

First bloom May 18–22d, abundant bloom May 29th. First ripe berry June 21st, last July 12th.

This is a variety of but medium value here. It is reported very favorably from the Georgia and the Michigan Stations, fairly well from Pennsylvania, but very poorly from Montana.

Bubach (No. 5).—pistillate. Originated with J. G. Bubach, Princeton, Ill.

The plants are vigorous, leafstalks medium to long, leaflets large, broad, coarsely and abundantly toothed, frequently with small interposed serrations, dark green, trusses not numerous, medium length, bloom scant, flowers fair size, often quite irregular.

Berries medium to large, conic, flattened at tips, colored well into the flesh but not uniformly on the surface, firm, seeds deeply set, quality fair, yield poor.

First bloom May 19th, abundant 28th. First ripe berry June 15th, last July 10th.

The variety is reported poorly from the Georgia Station, but quite favorably from the Kansas, Michigan, Montana and Pennsylvania Stations and from Sheridan and Lander in Wyoming.

Capt. Jack.—bisexual. Originated in Missouri with a Samuel Miller.

The variety is a vigorous grower, producing plants in great abundance. The leafstalks are short and stout, the leaflets are medium size, broad-oval, dark green, leathery, notches equal and similar, main axes of trusses stout and upright, branches long and spreading, bloom abundant and held above the foliage, flowers medium size, broadly expanded, petals usually five, round, flat, stamens numerous and well developed.

Berries light crimson, regular conic form, size medium, color uniform, flesh lighter, quality fair to good, a good shipper, quite productive.

First bloom May 12–17th, abundant bloom May 20th. First ripe berry June 6–10th, full picking June 20–27th, last picking July 10th.

This is a good early to mid-season variety, but the berries become too small later. It is an excellent pollenizer and is reported quite favorably from Kansas and Wyoming.

Carrie.—pistillate. A seedling of Haverland.

Plants large and vigorous, reproducing sufficiently. The leafstalks are stout, leaflets medium to large, dark green, leathery, trusses long, ascending, bloom abundant, flowers medium size, stamens large for a pistillate variety.

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Berries resemble Haverland but are considerably larger, scarlet, firm, quality excellent.

First bloom May 19th, abundant bloom May 20–26th. First ripe fruits June 20–23d, last July 2d.

We consider this variety worthy of further trial. It is reported favorably from Michigan and Pennsylvania.

Cornelia.—bisexual.

This variety appears to be exactly like Glendale.

First bloom May 12th, full bloom May 25th. First ripe fruits June 17th, first picking June 22nd.

Reported favorably from Michigan and Pennsylvania.

Crawford.—bisexual. Originated with M. T. Crawford, Ohio.

The variety lacks vigor, producing but few plants. It has done too poorly to be worthy of description or further trial by us.

Crescent.—pistillate.

Plants of medium habit, very healthy and hardy, setting runners abundantly. The leafstalks are slender, leaflets long, frequently with two series of notches of very different size, color dark green, trusses medium length, bloom abundant, flowers small to medium, petals five, stamens rudimentary.

Berries medium size, conic with prolonged point, colored well, quality fair, acid, core somewhat cartilaginous, firmness and productiveness good.

First bloom May 12–16th, abundant bloom May 22d. First ripe berry June 7–15th, first picking June 15–20th, full picking June 27th, last July 10th.

The small size of the fruit, especially late in the season, is its chief fault. It is reported very vigorous and productive and of good quality and firmness from Georgia, Kansas, Michigan, Montana and Wyoming.

Cumberland.—bisexual.

Plants large, vigorous, setting young plants in sufficient numbers. The leafstalks are short and stout, the leaflets broad, roundish, bluntly toothed, medium dark green, trusses short to medium, stout, rays slender, bloom sufficient, flowers medium size, petals round, stamens well formed.

Berries large, short-conic to nearly globular, pale red, flesh light, hulls easily detached, appearance neat and smooth, quality excellent, rather soft, yield good.

First bloom May 15th, abundant bloom May 26th. First ripe fruits June 6–12th, first picking June 8–14th, full picking June 20–27th, last July 17th.

The variety is but slightly subject to frost injury. It is reported fair in Georgia, good in Kansas and very good at Sheridan, Wyoming.

Edgar Queen.—pistillate.

The plants are large and vigorous with abundant foliage, leafstalks are long and stout, leaflets medium to large, broad-ovate, medium shade green, teeth deep and sharp, trusses long, upright, stout, bloom very abundant, flowers medium size, petals six or more, frequenty the inner petals forming rudimentary stamens.

Berries medium to large, globular, scarlet but not uniformly colored, quality fair to poor.

First bloom May 22d, abundant bloom May 29th. First ripe fruits June 18th, full picking June 27th, last July 12th.

The variety is a late bloomer but has the fault of light color, the fruit being green in spots. Many berries failed to develop. It is reported very favorably from Georgia and Michigan but only fairly so from Montana.

Edwards' Favorite.—bisexual. Probably a seedling of Jucunda.

Plants small to medium size, vigorous, producing runners freely. The leafstalks are short and very strong, leaflets ample, light glossy green, medium size, short, broad-ovate, serrations broad and rounded, trusses medium length and thickness, upright, bloom abundant, flowers medium to large, petals usually five but often more, frequently curled, pollen sufficient, calyx adherent.

Berries especially beautiful, large, uniform size, short-conic, smooth, bright scarlet, seeds light color, flesh firm.

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First bloom May 10-16th, full bloom May 21st. First ripe berry June 15th, full picking June 20-27th, last July 17th.

The variety is an early bloomer. It is reported very favorably, except in vigor, from the Michigan Station.

Enhance.—bisexual.

Plants medium to large, vigorous, medium to light green, leafstalks long slender, erect, leaflets medium size, oval, teeth long and sharp, trusses short to medium, bloom abundant, flowers large, petals usually more than five, irregularly arranged, stamens well formed.

Berries medium size, crimson, tips slow in coloring, badly ribbed and irregular, sour, firm.

First bloom May 10-15th, full bloom May 12-23d. First ripe berries June 10-15th, first picking June 15-20th, full picking June 27th, last July 17th.

The variety is better for hill culture than for growing in matted rows. It is of low value with us, although it is a fairly good fertilizer for Bubach. It is reported very favorably from Georgia and Michigan and fairly so from Montana.

Eureka.—pistillate. Originated with Geo. Townsend, Soneham, Ohio, 1881.

Plants small to medium, producing sufficient young plants, leafstalks long and fairly strong, leaflets medium size, broad to long-ovate, deeply, sharply and irregularly notched and medium to dark green, trusses irregular in length, usually long and but little branched, mostly prostrate when loaded with fruit, bloom abundant, flowers small to medium, petals five to six, usually more, stamens undeveloped.

Berries large, scarlet to crimson, pink flesh, conic, frequently irregular in form and slow in coloring at tips, quality good, acid, firm, yield fair to good.

First bloom May 18-20th, full bloom May 26th. First ripe berry June 13-17th, full crop June 27th to July 6th, last picking July 17th.

The variety is late in blooming and ripening. It is of medium value with us. In Southern California it ranks low in bearing and in growth of vine.

Gandy.—bisexual.

Plants large and vigorous, do not run freely, best adapted to hill culture. Leafstalks very stout, leaflets large, long-ovate, coarsely toothed, medium to dark green, trusses long and stout, bloom abundant, flowers large, petals often more than five and frequently folded and irregular in appearance, stamens well developed, calyx large and reflexed.

Berries large, irregular, short-conic, frequently with a short neck, color bright scarlet, sometimes slow in coloring at tips, flesh light colored, seeds prominent, quality fair to good, firm.

First bloom May 17th, abundant bloom May 26th. First ripe berry June 18-21st, full picking June 26th to July 7th, last July 15th.

The variety is late in blooming and ripening and is of but moderate value. It is reported most unfavorably from Georgia, moderately favorably from Kansas, and very favorably from Michigan, Montana, New York, Pennsylvania and Sheridan, Wyoming.

Glendale.—bisexual.

Variety of tall habit, light green color, vigorous, produces sufficient young plants, leafstalks long, carrying the leaves frequently eight to twelve inches high, leaflets eliptical or oblong, finely serrate, trusses very long, bloom abundant, flowers medium to large, petals usually five but occasionally numerous, stamens fairly numerous and well developed, the first flower of each truss usually more or less compound.

First bloom May 19th, abundant bloom May 27th. First ripe fruit June 20-25th, full picking June 20th to July 6th, last July 17th.

The variety is like Seedling of Downing. It is of but little value here. The Kansas Station reports it very unproductive.

Greenville.—pistillate.

Plants large, dark green, vigorous, forming full matted row, leafstalks tall, leaflets large, broad, dark green, often streaked with light, sometimes curled slightly, coarsely notched, trusses medium long, stout, bloom sufficient, flowers small to medium, petals five to six, stamens none.

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Berries medium to large, broad-conic, symmetrical, crimson, flesh colored, quality, firmness and yield good.

First bloom May 16th, abundant bloom May 22d. First ripe berry June 11-13th, first picking June 13-15th, full picking June 20-27th, last July 17th.

This is one of our best medium to late varieties. It is reported unfavorably from Georgia, Montana and Southern California Stations, but quite favorably from New York and Michigan.

Gold.—pistillate. Originated with P. M. Angar & Sons, Conn., 1880.

Plants medium size, pale yellowish color, lacking in vigor. Leafstalks medium length, somewhat drooping, leaflets medium size, broad-oval, trusses short, stout, bloom sufficient, flowers small, petals usually five with occasionally a partial inner circle.

Berries medium to large, short-conic, scarlet, flesh ditto, quality fair to good yield poor.

First bloom May 12th, full bloom May 22d. First ripe berry June 16th, first picking June 17th.

The variety is not a success under our conditions. It is reported quite unfavorably from Georgia and Sheridan, Wyoming.

Gov. Hoard.—bisexual. Originated in Wisconsin, a seedling of Sharpless.

The plants are large and quite reproductive. The leafstalks are long and stout, leaflets large, broad-ovate, medium green, trusses medium length, stout, bloom abundant, flowers large, petals usually five, stamens well formed.

Berries medium size, short-conic with neck, red all over, flesh colored well in, only fair in quality, firmness and yield.

First bloom May 12th, first picking June 17th.

Subject to frost injury, of no value on our grounds. Reported quite favorably from the Michigan Station.

Gypsy.—pistillate.

Plants of low habit, forming a thickly matted row. Leafstalks short and stout, leaflets broad, coarsely toothed, dark green in color, trusses short to medium, bloom sufficient, flowers small to medium, petals usually five, stamens none.

Berries medium size, short, round-conic, very symmetrical, uniform deep crimson color, flesh ditto, quality excellent, firm, yield medium.

First bloom May 16-18th, abundant May 21st, full bloom May 25th. First ripe berry June 5-14th, first picking June 11-15th, full picking June 20-27th, last July 12th.

We consider this an excellent variety and worthy of further trial. It is reported very favorably from Michigan, but at the Kansas Station is said to be a complete failure.

Haverland.—pistillate.

Plants of medium size, healthy and fairly vigorous although somewhat subject to leaf-curl. Forms a poor stand in matted row. Leafstalks are medium long, leaflets medium to large, rather broad, sharp toothed, medium shade green, trusses short to medium, more or less prostrate with twelve to sixteen blooms per truss, flowers small, parts arranged in plan of five, stamens none.

Berries very long with a neck, light scarlet, flesh ditto, quality very good, yield good.

The trusses are not strong enough to support the fruit. The calyx is somewhat reflexed.

First bloom May 8th, abundant bloom May 18th, full bloom May 21st. First ripe berries June 5th, first picking 8-10th, full picking 27th, last picking July 10th.

Although the blossoms and leaves are somewhat subject to frost injury we regard this as one of our best early varieties. It is reported unfavorably from Georgia though quite productive, fairly well from Kansas and Montana, and quite favorably from Michigan, New York and Sheridan, Wyoming.

Hersey.—bisexual. Originated with Samuel Hersey, Hingham Mass.

Plants are of large and vigorous habit, reproducing abundantly. The leaf-

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stalks are short and stout, the leaflets large, elliptical, teeth short and sharp, trusses long, bloom sufficient, anthers numerous but often poorly developed.

Berries large, long-conic with neck, color good, yield poor.

First bloom May 17-19th, abundant bloom May 28th. First ripe berry June 20th, best yield June 28th, last July 12th.

The variety is unworthy of further trial here. It is reported unproductive at the New York Station.

Ironclad.—bisexual.

Plants are of low habit, vigorous, reproducing fairly well. The leafstalks are short and stout, leaflets oval or broad-ovate, glossy dark green color, trusses medium length, stout, bloom abundant, flowers small to medium, petals five, stamens numerous and well developed.

Berries small to medium, conic with tips, color dark red, flesh ditto, quality good, firm, yield low.

First bloom May 13th, abundant bloom May 19th. First ripe berry June 13th, first picking 17th, full picking June 20-27th, last July 12th.

The variety will be discarded as unworthy.

Ivanhoe.—bisexual. Originated in Southern Ohio with Geo. W. Trowbridge, of Hamilton county.

Plants thrifty, foliage ample, leathery, dark green, blossoms medium size.

Berries large, conic, symmetrical, colored well, quality excellent but with a slight core.

First bloom May 21st, abundant bloom May 25th. First ripe berry June 20th.

This is a promising variety here. It is reported favorably from the Montana Station.

Jay Gould.—pistillate. Originated in Eastern Ohio, 1887.

The plants are of medium size and color, trusses medium long, bloom scant, flowers medium to large, showy, petals five to eight in a single circle.

Berries small, round-conic, crimson, flesh lighter, much like Gypsy in form, color and flavor, but smaller.

First bloom May 16th, abundant bloom May 24th. First ripe berry June 14th, last picking July 12th.

Variety undesirable here. Reported very favorably from the Michigan Station but unfavorably from the Montana Station.

Jessie.—bisexual—pistillate. Originated with Jas. W. Loudon, Janesville, Wis.

Plants very large and vigorous, producing young plants freely. Leafstalks long, leaflets very long, teeth large and irregular, medium green, trusses long and stout, bloom abundant. We have two stains of the variety. The flowers are large in the perfect-blossomed strain and small in the pistillate. Both strains are very productive of large berries, the earliest of which are often flattened and slow in coloring at tips.

Berries light scarlet, flesh lighter, quality good, calyx large, seeds prominent, quite firm.

First bloom 12–14th, abundant bloom May 23–24th. First ripe berry June 10–12th, last picking July 17th.

The development of the pistillate strain is slightly in advance of the staminate. The chief fault of the variety is the uneven ripening of the first fruits. At the Southern California Station it ranks low in production and growth of vine, at the Kansas Station very low in production, at the Georgia Station it is regarded as a good variety for amateur culture only, and in Wyoming it is not very successful, but is reported very favorably from the Michigan Station.

Jucunda.—bisexual.

Plants large, medium green, leaflets large and long, trusses long, bloom abundant, flowers large, petals usually five but frequently numerous in a single circle, stamens well developed.

Berries large, conic, frequently ribbed and irregular, quality fair, acid, yield medium.

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First bloom May 12, full bloom May 22d. First ripe berry June 12th, first picking June 13th, last July 15th.

The variety was not a success here.

Jucunda Improved.—bisexual. Originated with A. B. Gerbert, of Eastern Pennsylvania. Probably a seedling of Jucunda.

The variety forms a thick mat of rather small plants, leaflets broad, medium green, bloom production fair, flowers large, petals usually six to seven but sometimes more, stamens well developed.

Berries a little broader than Jucunda, very large, crimson, surface smooth, short-conic, symmetrical, flesh pink, quality good, firm, yield low.

First bloom May 19th, abundant bloom May 29th. First ripe berry June 18–20th, full picking June 27th, last picking July 17th.

The variety rusts badly and is of little value here. It is reported very unfavorably from Georgia but quite favorably from Wyoming.

Jumbo.—bisexual.

A variety of the Sharpless type. Plants medium to large, medium vigor, fairly productive, leafstalks stout, medium to long, leaflets, large and broad-oval, deeply and sharply toothed, medium green in color, trusses medium long and medium stout with spreading, ascending branches, bloom production medium, flowers medium to large, petals usually six to ten, all somewhat curled, stamens imbricate and well developed.

Berries large to very large, oblong or somewhat rectangular, disposed to be irregular in form, color bright scarlet but slow in coloring at the tips, flesh nearly the same color, core somewhat stringy, quality fair, firmness and production medium.

First bloom May 9–12th, full bloom May 20th. First ripe berry June 15–18th, first picking June 19–20th, full picking June 26th, last July 8th.

This is a variety of strictly medium value here.

Lady Rusk.—pistillate.

The plants are large, running freely and making a full matted row. The leafstalks are long and stout, leaflets medium to large, long-ovate, rather unevenly toothed, medium to dark green, trusses medium to long, moderately stout, bloom production moderate, flowers small to medium, petals normally five, usually with undeveloped inner circle of two or three, stamens quite well developed for a pistillate variety.

Berries medium size, short, surface uneven and often more or less ribbed, dark crimson, tips slow in ripening, flesh yellowish pink, core soft or cartilaginous, quality and yield fair.

First bloom May 14–18th, abundant bloom May 21–23d. First ripe berry June 11–17th, first picking June 17–20th, full picking June 27th, last picking July 10th.

The plants and fruit much resemble the Crescent, although the fruit is more irregular in shape. It is a variety of medium value here. It has done fairly well in Kansas and Wyoming.

Lady Thompson.—bisexual.

Plants of medium habit, setting runners freely, large, vigorous, dark green, bloom sufficient, flowers large, stamens well formed.

Berries fair size, symmetrical, conic, often gemmate or twined, quality fair, yield good.

First bloom May 22d, abundant bloom May 25th. First ripe berry June 19th, last picking July 2d.

The variety is only moderately promising. It has done fairly well at the Georgia Station, but is pronounced a failure in New York, Ohio and Southern California.

Leader.—bisexual. Originated in Reading, Mass.

Plants of medium habit and vigor, producing young plants in sufficient number. Leafstalks short, leaflets medium to large, medium green, nearly round, small serrations frequently occurring between the larger ones, trusses medium long, stout, bloom production medium, flowers large and showy, calyx

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large, sepals and petals usually exceeding the normal number, stamens numerous and well developed, pistils ditto.

Berries large, broad-conic and symmetrical but quite small after the first few pickings, deep scarlet, flesh ditto, seeds prominent, crimson, firm, quality good, acid, yield good.

First bloom May 16, abundant bloom May 21st. First ripe berry June 11–16th, first picking June 15–20th, full picking June 27th, last July 10.

The berries much resemble Warfield in shape and color. The plants have not been thoroughly healthy with us and were somewhat injured by frost in 1896. Reported inferior in production and flavor in Southern California, but very favorably except in vigor at the Michigan Station.

Lida.—pistillate. Originated with Wm. Parry, N. J., from seed of Chester.

Plants large and vigorous, reproducing freely, leafstalks medium to long, stout, leaflets medium size, broad-ovate, dark green, trusses medium to long, bloom fairly abundant, flowers medium size, petals five, many stamens fairly developed.

Berries large, short-conic or globular with a smooth surface, uniform light scarlet, flesh paler, quality good to excellent, a little soft, yield good.

First bloom May 10–12th, full bloom May 21–28th. First ripe berry June 12th, first picking June 13th.

It is reported low in vigor and production from Kansas and but slightly better from the Michigan Station.

Loudon.—bisexual.

Plants large but rather low in habit, a good plant producer, leafstalks medium long, stout, sharply and unevenly toothed, light green, trusses medium to long, stout, bloom sufficient, flowers large, petals usually five but sometimes six or more, stamens well formed.

Berries large, broad-conic, nearly globular, crimson but sometimes not uniformly so, flesh pale, quality fair to good, firm, calyx large and conspicuous.

First bloom May 10th or earlier, abundant bloom May 12–19th. First ripe fruits June 13–17th, full picking June 20–26th, last July 8th.

Variety of medium value. Reported very unfavorably from Georgia.

Louisa.—bisexual. Originated with Nicholas Hallock, of New York. Introduced by W. A. Burpee, 1888.

Plants medium to large, reproducing but moderately. Leafstalks long, medium strong, leaflets large, coarsely and often unevenly toothed, new leaves thin and light green but darker with age, flowers medium size, petals usually five, many blossoms pistillate.

Berries very large, oblong, with neck, light scarlet, flesh nearly white, seeds deeply set, flavor excellent, a little soft.

First bloom May 19th, abundant bloom May 26th. First ripe berry June 10–15th, first picking June 15th, full picking June 20th to July 7th, last July 15th.

A very good variety. Reported low in vigor and productiveness at the Kansas Station.

Lovett.—bisexual. Originated in Kentucky in 1885. Believed to be a chance seedling of Crescent x Wilson.

Plants of medium habit, healthy but somewhat subject to leaf curl, quite reproductive, leafstalks medium long, stout, leaflets medium size, thin, broad-ovate, sharply and irregularly toothed, medium to dark green, trusses short, stout, bloom abundant, flowers medium to large, petals usually five but frequently six to eight, stamens medium and well developed, calyx large.

Berries medium size, conic to long-conic, crimson, quality good, acid, firm, yield medium.

First bloom May 15–17th, full bloom May 22d. First ripe berry June 10–14th, full picking June 20–27th, last pick July 7th.

A variety of medium value here. Reported very unfavorably from Georgia, but better from Michigan, Montana and Sheridan, Wyoming.

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Louella.—bisexual.

Plants large and vigorous, reproducing abundantly. Leafstalks medium long, erect, stout, leaflets large, long-ovate, medium green, trusses long and strong, bloom abundant, carried high, flowers large, petals five to six, stamens well developed, pollen very abundant.

Berries large, irregular-conic with neck, dark red, tips frequently green, flesh highly colored, quality good, acid, yield medium.

First bloom May 17th, full bloom May 21–27th. First ripe berry June 11th–23d, first picking June 15th, full picking June 27th, last July 15th.

Manchester.—bisexual.

Plants of medium habit, dark green, leathery, very like if not identical with Cumberland. Leafstalks short and stout, leaflets large, broad to round, serrations short, blunt and irregular, trusses medium long, bloom fairly abundant, flowers medium to large, petals usually five, stamens well developed.

Berries large, broad-conic, symmetrical, surface smooth and even, light scarlet, flesh light, seeds prominent, quality very good, not firm, yield fairly good.

First bloom May 10th, full bloom May 25th. First ripe fruit June 11–14th, first picking June 20–27th, last picking July 15th.

The variety is reported very productive at the Kansas Station, but is reported quite unfavorably from Georgia and from Sheridan, Wyoming.

Margaret.—bisexual. Originated with Jno. F. Beaver, Dayton, O., about 1891, from seed of Crawford.

The variety is a vigorous grower of medium habit, reproducing fairly well. Leafstalks medium long, stout, leaflets broad, coarsely toothed, leathery, trusses medium long, stout, bloom abundant, flowers large, petals five to nine, a good pollenizer.

Berries large, broad-conic, light crimson on exposed surface, scarlet on shaded portions, flesh pink to white, quality good, firm, yield fair.

First bloom May 13th, abundant bloom May 22d. First ripe fruit June 13th, first picking June 20th, full picking June 27th, last July 12th.

A good variety, deserving of trial. It is reported to be a promising pistillate variety at the Pennsylvania Station.

Marshall.—bisexual. Originated in Mass., introduced to the public in 1893.

Variety medium to large, vigorous, fairly reproductive. Leafstalks medium long, stout, leaflets large, broad, irregularly toothed, medium to light green, spotted to some extent, trusses medium to long, stout, bloom scant, flowers large, petals five to seven, in one whorl, occasionally some in an inner circle.

Berries large, broad-conic, crimson, tips often greenish, quality good.

First bloom May 15th, full bloom May 22nd. First ripe berry June 13th, first picking June 30th, last July 12th.

This is a promising variety, but it probably requires extra culture. It is reported very favorably from the Georgia and Michigan Stations.

Michels Early.—bisexual.

The variety is a very vigorous grower, of medium habit, setting plants and bloom profusely. It is an excellent pollenizer.

Mrs. Cleveland.—pistillate.

Plants large and vigorous, reproducing abundantly, leafstalks stout, leaflets ample, broad, coarsely toothed, light green, trusses medium long, bloom sufficient, flowers medium size, petals usually five, stamens none.

Berries large, round-conic, surface even, light scarlet, flesh light, quality excellent, slight core, firmness medium, yield good.

First bloom May 13th, abundant May 23d. First ripe berry June 13–15th, first picking June 16th, full picking June 26th, last July 8th.

An excellent kitchen variety. It is reported fair at the Kansas and good at the Michigan Station.

Monarch.—bisexual.

The plants are large and vigorous, leafstalks medium to long, leaflets small to medium, ovate, deeply notched, light green, trusses medium to long, stout,

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bloom abundant, flowers medium to large, petals five to eight, imbricate, inner ones frequently much like the stamens, stamens medium size, numerous.

Berries large, conic, pale scarlet, inner flesh white, soft, quality good, yield good.

First bloom early, full bloom 1896 May 12th, abundant bloom 1897 May 27th. First ripe berry June 8–16th, first picking June 11th, last July 17th.

While inclined to bloom early, the variety is quite late in bearing, producing its full crop the latter part of June. The berries do not ripen evenly. Reported poorly from Georgia.

Ontario.—bisexual. Introduced from Canada by R. Johnston, of New York, 1885.

The variety is not vigorous nor productive of plants. Leafstalks medium long, stout, leaflets medium to large, light green, few in number, texture thin, trusses short, stout, drooping, branches long, bloom scant, flowers large, petals usually numerous and much folded, stamens well formed, calyx large.

Berries medium to large, oblong-conic or broader, scarlet, flesh colored, quality good, yield medium.

First bloom May 11th, full bloom May 22d. First ripe berry June 12th, last picking July 8th.

The variety has not done well. The fruit and foliage are both subject to frost injury. Reported fairly well from Georgia, excellent from Michigan, but very unproductive from Kansas.

Parker Earle.—bisexual. Originated 1886 with J. Nimon from seed of Crescent x T. V. Munson's No. 3.

Plants of medium size and vigor, reproducing abundantly. Foliage abundant, leafstalks long, erect, leaflets frequently unevenly notched, medium green, trusses medium long, stout, many-branched, sometimes as many as twenty per truss, bloom abundant, flowers medium size, petals usually five well formed, stamens numerous and well developed.

Berries large, long-conic, neck long, tips truncate, seeds depressed, color uniform scarlet, flesh lighter, quality good, firm, yield excellent, calyx reflexed.

First bloom May 17th, full bloom May 22–24th. First ripe berry June 15–19th, first picking June 20th, full picking June 27th, last July 12th.

This is our very best commercial variety. It is reported favorably from Georgia and very favorably from Michigan, rather unfavorably from Montana and Wyoming and poorly from Southern California.

Pearl.—bisexual. Originated in New Jersey.

Plants of Crescent type but smaller, leafstalks medium long, leaflets small, long-ovate, medium green, but slightly injured by frost, trusses short, bloom abundant, flowers medium size, petals five, stamens well developed.

Berries large, conic, symmetrical crimson, flesh ditto, quality good, soft, yield good.

First bloom May 12th, full bloom May 22d. First ripe berry June 10th, first picking June 15th, last July 15th.

Although lying on the ground, these are among our handsomest and best berries. Reported to be lacking in vigor and yield in Georgia and Kansas.

Phillips.—bisexual. A seedling of Sharpless.

Vigorous until attacked by mildew and spot. Leafstalks medium to long, slender, foliage ample, medium to dark green, leaflets medium size, oval, trusses shorter than leafstalks, bloom scant, flowers very large, petals usually six to eight, pollen abundant for a number of flowers.

Berries large, conic, truncate, badly ribbed, unevenly crimson, quality poor.

First bloom May 19th, full bloom May 24th. First ripe berry June 20th, last June 26th.

Not a promising sort. Reported favorably from the Michigan Station and from Georgia, when grown with Parker Earle.

Princess.—pistillate. Originated in Minnesota.

A low, vigorous grower resembling Pearl, although somewhat earlier and the fruit more nearly globular. Plants small to medium, leafstalks short, leaflets

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medium size, broad, medium to dark green, truss axes short to medium, bloom production fair, flowers small to medium, petals not imbricate.

Berries medium size, short-conic to globular, deep crimson, flesh light scarlet, seeds deeply set, quality and yield good.

First bloom May 10-14th, full bloom May 19-22d. First ripe berry June 6-11th, last picking July 8th.

A good early to medium variety. Reported from Georgia as a poor grower but a very heavy mid-season cropper, the best on the Station grounds. It is reported very favorably from Michigan but poorly from Montana.

Princeton Chief.—pistillate.

Variety of tall habit, vigorous, reproducing abundantly. Leaflets large, long, somewhat tapering toward apex, light green, trusses exceedingly long, somewhat overtopping the leaves, bloom very abundant, flowers large, petals five to nine, stamens considerably developed.

Berries large, dark crimson, form irregular, yield good.

First bloom May 19th, abundant May 24th. First ripe berry June 21st, last July 17th.

This is a very late, promising variety. Reported unfavorably from Montana, from Georgia as lacking in form and productiveness, but very favorably from the Michigan Station.

Puritan.—pistillate.

Plants after the Crescent type but taller and the leaflets more sharply toothed. It is a very healthy and vigorous variety, forming plants abundantly, leafstalks long and stout, leaflets medium to large, dark green, serrations small, trusses medium to long, bloom sufficient, flowers medium size, petals usually five, stamens none.

Berries medium size, conic, irregular, surface uneven, crimson, very acid, yield good.

First bloom May 16th, abundant bloom May 28th. First ripe berry June 16th, full picking June 26th; last July 8th.

A late variety, poor to medium in value.

Rio.—bisexual.

A variety of Crescent type. Plants low in habit, vigorous, reproducing freely, leafstalks short and slender, leaflets small, light to medium green, trusses short and upright, bloom sufficient, flowers medium size, petals usually five, stamens well formed.

Berries medium size, broad-conic with somewhat prolonged point, bright scarlet, flesh ditto, quality good, acid, core cartilaginous, yield fair.

First bloom May 16th, abundant bloom May 22d. First ripe berry June 13th, last picking July 2d.

The variety is not desirable under our conditions. Reported unproductive at the Georgia Station, but favorably from Michigan.

Seedling of Downing.—bisexual.

A very vigorous variety, setting runners and young plants abundantly. Plants large, leafstalks long, stout, leaflets large, long and narrow, uniformly notched, light green, truss axes long and upright, bloom abundant, flowers small, calyx especially small, bowl-shaped, stamens well formed but not numerous.

Berries medium size, long-conic, scarlet, flesh ditto, seeds deeply set, giving the surface a rasp-like appearance, the seeds on the exposed surface becoming red while the flesh is still white, quality good, not a good shipper, yield fair.

First bloom May 12th, abundant bloom May 20th. First ripe berry June 14–17th, full picking June 20–26th, last picking July 12th.

Unworthy of trial under our conditions.

Shuster's Gem.—pistillate. A cross of Crescent x Sharpless.

Variety large, thrifty, reproductive, leafstalks long, slender, leaflets large, oval, light green, trusses medium to long, upright, bloom fairly abundant, flowers medium size, petals none.

Berries medium size, conic, symmetrical, clear scarlet, flesh lighter, quality good, sweet, lacks firmness, yield good.

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First bloom May 12th, full bloom May 20th. First ripe berry June 10th, first picking June 15th, full picking June 20-27th, last July 10th.

A promising variety, worthy of trial. Reported favorably from Georgia, Kansas, Pennsylvania and Wyoming, but unfavorably from Montana and Southern California.

Splendid.—bisexual.

A large and vigorous variety, producing a full matted row. Plants large, leafstalks medium to long, leaflets large, oval, pointed, dark green, trusses medium to long, bloom abundant, flowers medium size, petals five to six.

Berries large, short-conic, blunt, crimson, flesh pale pink, white toward centre, tardy in coloring at tip, quality good, core sometimes cartilaginous, yield good.

First bloom May 17th, abundant bloom May 23d. First ripe berry June 17th' first picking June 20th, full picking June 27th, last picking July 12th.

A promising variety. Reported favorably from Michigan and Montana.

Stayman's No. 1.—bisexual. Originated in Southern Ohio. A seedling of Warfield.

Plants of medium size and vigor, reproducing fairly well. Leafstalks short to medium, leaflets medium size and shape, deeply notched, dark green, truss axes long, usually declined, bloom abundant, flowers small with parts arranged in order of five, petals smooth, stamens none.

Berries medium size, sometimes with a short neck, calyx reflexed, fruit conic, frequently double or even triple, the individuals being united to the tips, scarlet, flesh pink, core frequently cartilaginous, quality fair to good, acid, yield fair.

First bloom May 13th, abundant bloom May 22d. First ripe berry June 12th, first picking June 15th, full picking June 20-26th, last picking July 15th.

A variety of very moderate value. Reported favorably from Montana and Sheridan, Wyoming, but from Georgia as being very unproductive.

Summit.—pistillate. Originated with M. Crawford, Ohio, as Crawford's No. 6.

Plants large, vigorous, reproducing abundantly, leafstalks medium long, stout, leaflets medium large, round or broad ovate, medium shade green, bloom sufficient but many barren plants, stamens often well developed.

Berries large, uniform, short-conic, quality and yield good.

First bloom May 10-12th. First ripe berry June 5th, first picking June 13th.

A desirable berry for home use. From Kansas reported to be extremely unproductive.

Tennessee Prolific.—bisexual. Seedling of Crescent x Sharpless.

Plants of medium habit, vigorous, reproducing abundantly. Leafstalks slender, leaflets medium long, unequally serrated, trusses medium long, mostly declined, bloom abundant, flowers large, petals five to six, anthers usually well formed, but the flowers sometimes partially pistillate.

Berries small to medium, irregular, color crimson to scarlet, flesh colored, core sometimes cartilaginous.

First bloom May 17th, abundant bloom May 22d. First ripe fruits June 5th, last picking July 12th.

The value of the variety is rather uncertain. Reported rather favorably from Michigan, but as being of little value at the Montana Station.

Thompson.—bisexual.

Plants of medium size, vigorous, reproductive, leafstalks long and slender, leaflets small to medium, long, teeth sharp, medium to dark green, trusses short and stout, branches long, bloom abundant, flowers medium size, petals often over five, stamens well formed.

Berries large, uniform, conic, pointed, occasionally with neck, bright scarlet, seeds light colored and prominent, quality excellent, mild acid, firm, yield excellent.

First bloom May 9th, full bloom May 20th. First ripe berry June 5th, first picking June 15-20th, last picking July 8th.

This is our best early variety. With Haverland in season.

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Timbrell.—pistillate. Originated with H. S. Timbrell, of New York.

The variety is large, coarse and vigorous, but it does not set young plants freely. Leafstalks long and strong, leaflets broad-ovate, foliage strong, medium green, trusses short and stout, bloom abundant on individual plants, flowers medium size, petals five, stamens usually none but often well formed.

Berries medium to large, short-conic to globular, deep crimson with paler spots, quality good to excellent, firm.

First bloom May 17th, abundant bloom May 24th. First ripe berry June 16th, first picking June 18th, full picking June 27th, last July 17th.

The variety has not succeeded well. It is reported fairly well from Michigan, but as being very unproductive in Montana and Georgia.

Tippecanoe.—bisexual. Originated from seed brought from France.

A variety of medium habit, producing plants abundantly, leafstalks medium long, stout, leaflets medium to large, broad-ovate with rounded teeth, color dark green, trusses medium long, bloom sufficient, flowers large, petals usually five to eight in a single series, stamens usually well formed but sometimes undeveloped.

Berries large, regular globular form, scarlet, sometimes a little slow in coloring at tips, flesh yellowish pink, calyx large, quality and yield good.

First bloom May 15th, abundant bloom May 24th. First ripe berry June 12-16th, first picking June 15-19th, full picking June 26th, last July 15th.

A mid-season variety. It is one of our best large berries.

Van Deman.—bisexual. Originated with a Mr. Bauer.

Plants medium size, dark, glossy green, sets young plants abundantly, leafstalks medium long, leaflets medium size, long-ovate, trusses short, stout, much branched, bloom abundant, flowers medium size, petals five, stamens numerous and well developed.

Berries medium size, conic, uniform deep red, flesh ditto, seeds prominent, quality good, yield poor.

First bloom May 12th. First ripe berry June 11th, first picking June 15th.

The variety is somewhat subject to frost injury. It is reported rather unproductive from Kansas, Michigan and Montana, but of excellent quality and firmness.

Warfield.—pistillate. Originated with B. C. Warfield in Southern Illinois, 1883. Probably a seedling of Crescent.

Plants medium size, vigorous and healthy, very reproductive, leafstalks long, slender, leaflets medium-oval but sometimes narrower, sharply toothed, medium to dark green, trusses medium long, stout, bloom abundant, flowers small, parts usually arranged in order of five, stamens rudimentary, pistils a peculiar yellow color.

Berries large, uniform, symmetrical, conic, with a sharp tip and sometimes a short neck, deep crimson, flesh ditto, quality good, acid. firm.

First bloom May 13th, abundant bloom May 19th. First ripe berry June 5-12th, first picking June 11th, full picking June 26th, last picking July 18th.

This is our best pistillate variety. It ranks next to Parker Earle as a commercial berry. Beder Wood is probably its best pollenizer.

The variety is not valuable at the Georgia Station, but it ranks high in the reports from Kansas, Michigan, Montana and Wyoming.

Westlawn.—bisexual.

Plants of tall habit, large and healthy, setting young plants abundantly. Leaflets large and broad, coarsely toothed, light green, trusses long, slender, upright, bloom sufficient, flowers medium size, petals frequently six, stamens none.

Berries medium to large, uniform, broad- conic, tip long, irregular and slow in coloring, color deep scarlet, flesh light, seeds deeply set, calyx large, parting easily from fruit, quality only fair, acid, firm, yield fair.

First bloom May 12th, abundant bloom May 22d. First ripe fruit June 12-14th, full picking June 26th, last picking July 8th.

A fair mid-season variety. Unworthy of trial.

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Wilson's Albany.—bisexual.

Plants small to medium, reproducing poorly, leafstalks medium long, stout, leaflets large, broad-ovate, medium dark green, trusses medium long, stout, bloom sufficient, flowers medium size, stamens well developed.

Berries small to medium, conic, crimson, flesh ditto, quality fair, acid, yield fair to good.

First bloom May 12th, blossoms but slightly subject to frost injury.

An undesirable variety. Reported unproductive at the Montana Station.

Woolverton.—bisexual. Originated with Jno. Little, of Canada.

Variety a robust grower but not easily established on heavy soils. Leafstalks medium to long, stout, leaflets ample, deeply toothed, flexible, long-oval, medium green, trusses long, stout, upright, flowers large, petals six to seven, many flowers with some petals imperfectly formed, stamens normal, calyx conspicuous.

Berries large, conic, sometimes flat at tip, deep crimson all over and well to centre, seeds prominent, firm, yield and quality good.

First bloom May 16th, abundant bloom May 25th. First ripe berry June 8-12th, first picking June 15th, full picking June 20-24th, last July 5th.

A good variety in many places Reported quite favorably from Michigan but as being quite unproductive from Georgia.

Yale.—bisexual. Originated as a chance seedling in New Haven, Conn.

Plant of Warfield type but more robust, large and vigorous, leafstalks long, stout, leaflets long, broad, coarsely notched, dark green, trusses long, stout, upright, much branched, bloom abundant, flowers small, petals imbricate, round, stamens usually well formed but sometimes quite rudimentary.

Berries large, conic with prolonged tip, scarlet, flesh ditto, seeds light colored, quality fair, soft, yield poor.

First bloom May 14th, abundant bloom May 22d. First ripe berry June 15th, full picking June 20-25th, last July 10th.

A mid-season variety of medium value. Reported from the Georgia Station as very unproductive.

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TABLE.

ABBREVIATIONS.

Sex.
p, pistillate.
b, bisexual.

Form.
b, broad.
c, conic.
d, depressed.
i, irregular.
r, round.
n, with a neck.

Size.
s, small.
m, medium.
l, large.

Color.
l, light.
r, red.
s, scarlet.

VARIETY.	Sex.	Vigor (1-10).	Date first bloom.	Date first ripe fruits.	Date last picking.	Productiveness, (scale 1-10).	Size.	Form.	Color.	Quality.	Firmness.
Annie Laura	b	8	May 19	June 19	July 12	6	l	dc	bc	6	7
Aroma	b	8.5	" 19	" 20	" 7	7	m-l	bc	s	7	7
Atlantic	b	8.5	" 14	" 12	" 8	7	m-l	bc	lr-s	8.5	6.5
Barton	p	8	" 13	" 14	" 17	9	m	bc	s	8.5	9
Beder Wood	b	8	" 14	" 11	" 10	8.5	m	rdc	s	8	8.5
Belle of LaCrosse	b	8.5	" 14	" 13	" 15	9.5	m	c	s-c	8	8.5
Bessie	p	8	" 17	" 11	" 2	4	s-m	c	dr	7.5	9
Beverly	b	8	" 12	" 15	" 10	7.5	m	bdc	c	8	7
Bisel	p	8	" 19	" 19	" 2	.....	s	c	c	7	.....
Boynton	p-b	9	" 13	" 10	" 17	9	m	bc	s	8	8.5
Brandywine	b	8	" 20	" 21	" 12	. . ..	l	bc	dc	.....	.....
Bubach No. 5	p	8	" 19	" 15	" 10	9.5	m-l	ic	s	7	8
Capt. Jack	b	9.5	" 14	" 10	" 10	8	m	c	c	8	9
Carrie	p	8	" 19	" 21	" 2	8.5	m-l	lc	s	9.5	9
Cornelia	b	8	" 12	" 17	.....	.....	.....	.....	.....	.....	.....
Crescent	p	8	" 13	" 10	July 10	8	m	lc	lc	8	8
Cumberland	b	8	" 15	" 12	" 17	8.5	l	bdc	lr	9.5	7.5
Cyclone	b	9.5	" 13	" 13	" 10	8.5	s	lnc	s	8	8.5
Edgar Queen	p	10	" 22	" 18	" 12	8	m-l	bdc	s-l	7	.....
Edward's Favorite	b	8	" 12	" 15	" 17	8.5	m-l	bc	bs	9	9
Enhance	b	7.5	" 12	" 12	" 17	8	m	bic	c	8	9
Eureka	p	7.5	" 18	" 14	" 17	8	m-l	ic	s-c	8	9.4
Gandy	b	8.5	" 17	" 19	" 15	8	l	ibcn	bs	8	9
Glendale	b	8.5	" 19	" 20	" 17	7	m-l	lc	ls	7	7
Greenville	p	9	" 16	" 13	" 17	8	m-l	c	c	8	8.5
Gold	p	7	" 12	" 16	" —	5	m-l	bc	s	7.5	8
Gov. Hoard	b	9	" 12	" 14	" —	7	m	bcn	r	7	7
Gypsy	p	8.5	" 16	" 8	" 12	8	m	bc	dc	10	9.5
Haverland	p	8	" 8	" 5	" 10	9	m	lcn	ls	8 5	8.5
Hersey	b	9.5	" 17	" 20	" 12	6	l	lcn	s	7.5	8
Ironclad	b	8.5	" 13	" 13	" 12	7	s-m	lc	dr	8	8.5

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TABLE—(Continued).

VARIETY.	Sex.	Vigor (1-10).	Date first bloom.	Date first ripe fruits.	Date last picking.	Productiveness, (scale 1-10).	Size.	Form.	Color.	Quality.	Firmness.
Ivanhoe	h	9	May 21	June 20	July 12	8	l	c	c	9.5	9
Jay Gould	p	8	" 16	" 14	" 12	7.5	s	bdc	dc	9.5	8.5
Jessie	b-p	10	"12-14	"10-12	" 17	8.5	l	c-ic	ls	9	9
Jucunda	b	8	" 12	" 12	" 15	7.5	l	lc	s	7.5	8
Jucunda Improved	b	8.5	" 19	" 19	" 17	7	l	c	c	8.5	8.5
Jumbo	b	8	" 9	" 15	" 8	8	l-vl	ldic	bs	7	7
Lady Rusk	p	10	" 14	" 13	" 10	7	m	bic	dc	7	7
Lady Thompson	b	9	" 22	" 19	" 2	9.5	m	c-ic	s-c	7.5	8
Leader	b	7	" 16	" 13	" 10	8	m-l	bc	ds	8	9
Lida	p-b	9	" 11	" 12	" —	8	l	bc	ls	9	7.5
London	b	8.5	" 10	" 13	" 8	8	m-l	bdc	s-c	8	9
Louisa	b-p	8	" 19	" 12	" 15	.....	vl	ldcn	ls	9.5	8
Lovett	b	8.5	" 15	" 11	" 7	8	m	c-lc	c	8.5	9
Louella	b	9.5	" 17	" 14	" 15	8	l	icn	dr	8.5	8.5
Manchester	b	8	" 10	" 12	" 15	8	l	bdc	ls	9.5	7.5
Margaret	b	3	" 13	" 13	" 12	7.5	l	bc	lc	8.5	9
Mark	b	9	" 14	" 20	" 15	8	m	bc	s-c	5	9
Marshall	b	8	" 15	" 13	" 12	8.5	l	bc	c	8	8
Mrs. Cleveland	p	9.5	" 13	" 13	" 8	8.5	l	rc	ls	9	8
Monarch	b	8.5	" 8	" 10	" 17	8.5	l	c	ls	8	7
Ontario	b	5	" 11	" 12	" 8	7	m-l	ldc	s	8.5	8
Orange Co.	p	7	" 13	" 13	" 12	7	m	brc	ls	8.5	8
Parker Earle	b	9.5	" 17	" 16	" 12	10	m	lcn	ds	8	9
Pearl	b	8	" 12	" 10	" 15	8	l	c	c	9	8
Phillips	b	8	" 19	" 20	June 26	8	m	lidc	lc-c	6	7
Princess	p	7.5	" 12	" 8	July 8	8.5	m	rc	dc	8.5	8
Princeton Chief	p	9.5	" 19	" 21	" 17	8.5	l	ic	dc	8.5	8.5
Puritan	p	10	" 16	" 16	" 8	8.5	m	ic	c	7	8
Rio	b	9	" 16	" 13	" 2	7	m	lbc	bs	8.5	7
Seedling of Downing	b	9.5	" 12	" 14	" 10	7	m	lc	bs	8	7
Shuster's Gem	p	9.5	" 12	" 10	" 10	8	m-l	c	bs	8.5	8
Splendid	b	10	" 17	" 17	" 12	8.5	l	bdc	c	8	8
Stayman's No. 1	p	8	" 13	" 12	" 15	7.5	m	icn	s	7.5	8
Summit	p	9	" 11	" 5	" —	8.5	l	bc	ls	8	7
Tennessee Prolific	b	8.5	" 17	" 15	" 12	.....	s-m	ic	c-s	8	8
Thompson	b	8.5	" 9	" 5	" 8	9.5	m	c-cn	bs	9.5	9.5
Timbrell	p	8	" 17	" 16	" 17	8	m-l	bdrc	dc	9	9.5
Tippecanoe	b	8	" 15	" 14	" 15	8	vl	rdc	s	8	8
Van Deman	b	9	" 12	" 11	" —	7	m	c	dr	8	8.5
Warfield	p	9	" 13	" 8	" 15	10	m	c	c	8	9.5
Westlawn	b	8	" 13	" 12	" 8	8	m-l	bc	ds	7	8.5
Wilson's Albany	b	7.5	" 13	.....	.....	8	s-m	c	c	7	8
Woolverton	b	8	" 16	June 12	July 5	8	l	c-ic	dc	8	9
Yale	h	9.5	" 14	" 15	" 10	7	l	lc	s	7	7

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Supplementary List of Varieties.

Since the publication of our last strawberry bulletin (No. 29, 1894), the following varieties, not found in the preceding list, have been introduced to the Station grounds. Of this number a few have failed to become established. The others will be reported upon as soon as sufficient trial has been given them:

Anna Kennedy,
Bouncer,
Clarence,
Cyclone,
Downing's Bride,
Enormous,
Gardner,
Great Pacific,
Hatfield,
Hunn,
Jersey Market,
Leo,
Manwell,
Murray X Early,
Ocean City,
Pet,
Pride of Cumberland,
Seaford,
Staples,
Vories,
William Belt,
Berlin,
Brunette,
Clark Early,
Cobden Queen,
Earliest,
Erie,
Giant,
Gros Lombard,
H. W. Beecher,
Ideal,
Klondyke,
McKinley,
Mary,
Nick Ohmer,
Oriole,
Plow City,
Ridgeway,
Sharpless,
Sunnyside,
Wild's No. 8,
Wilson,
Bismark,
Champion of England,
Clyde,
Darling,
Eleanor,
Equinox,
Glen Mary,
Halls,
Howell,
Improved Parker Earle,
Laxton,
Magoon,
Michigan,
Noble,
Patrick,
Premium,
Ruby,
Sparta,
Tubbs,
Wild's No. 35.

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The Agricultural Experiment Station

OF THE

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APIARY EXPERIMENTS.

—BY—

CLARENCE P. GILLETTE.

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APIARY EXPERIMENTS.

FOUNDATION IN COMB BUILDING.

By CLARENCE P. GILLETTE.

Honey bees collect liquid sweets from all available sources, chiefly in the form of nectar from flowers, and when the product has been elaborated in the honey-stomach and afterwards stored in comb, we call it honey.

The material from which the comb is built is not collected as wax, but is formed within the body and secreted in the form of thin scales between the abdominal segments on the under side.

As the wax is elaborated within the body, the bee must be supplied with food out of which to form it and, according to experiments reported on another page, it requires about one pound of wax for every twenty-five pounds of honey stored in comb. The food required for the secretion of wax is, for the most part, honey; and as it requires several pounds of corn to produce one pound of beef or butter, so it doubtless requires several pounds of honey as food for worker bees to enable them to produce one pound of wax.

But the consumption of honey for wax production does not represent the total cost of the wax to the colony. The bees that secrete it are called off from the field force, so that the income of the colony is lessened. In a state of nature this wax production entails no heavy drain upon the the colony, as the comb, once built, lasts for years; but where comb honey is being produced for the market, it becomes a matter of economic importance to know to what extent and in what form wax can best be furnished bees for their use in comb building.

So far as we know at present, there is but one general way to furnish the wax for this use, and that is in some form of artificial comb foundation. But their are many types of this foundation. Is it better to have the base or midrib only—the "no wall" foundation? or is it better to have the cell walls outlined for the bees? If the latter, should we have these walls short or long? In either case, is

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it better to put most of the wax in the midrib or the cell walls? When it is determined how the wax is best proportioned between the midrib and cell walls, what weight of foundation is best?

The experiments here reported were undertaken for the purpose of casting some light upon these and related problems and, it is believed, with some good results. It is not to be expected that all these questions are fully settled in this paper.

DO BEES USE WAX FROM ARTIFICIAL FOUNDATIONS TO EXTEND THE CELL WALLS AND THE COMB MIDRIB?

The common belief that wax is so used was graphically proven by the following experiment:

A few sheets of thin foundation that was made black by the addition of lamp black to the melted wax were prepared for me by Mr. C. B. Elliott, of Denver. This foundation was used in sections which were placed in supers for comb honey. In some sections starters one inch wide were used, while in others were placed full sheets. The bees accepted this black foundation as readily as any and built comb upon it. A photograph of comb built upon this foundation is shown in Plate 1. At *a* is a section containing a starter one inch wide that the bees had worked but little. At *b* are two cross sections of comb built upon such a starter. The white cross-lines show where the lower edges of the starters came, and the dark color shows to what extent the foundation was used in extending the comb. At *c* is a section of drawn comb built upon a short starter as shown at *a*. The white line marks the lower margin of the foundation, and the dark color in the comb shows to what extent the foundation was used in building down the comb. At *d* is shown comb built on a large piece of the black foundation. The cell walls are deep black at the bottom and gradually fade until the top or outer end of the wall is reached, where the dark color hardly shows. This could only come about by the bees using other wax, probably directly from their bodies, which was mixed with the wax of the foundation.

These experiments prove so conclusively that bees do use wax from foundations to extend both cell walls and midrib, that we are now ready to ask:

IS THE WAX OF THE MIDRIB OF THE FOUNDATION USED IN COMB BUILDING, AND, IF SO, WILL IT BE CUT DOWN TO THE THINNESS OF THE MIDRIB IN NATURAL COMB?

To determine these points we shall have to compare the thickness of the artificial foundation with the thickness of the comb midrib built upon the foundation, and the latter with the midrib of comb built entirely by the bees.

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Table Showing the Weight, in Grains per Square Inch, of Different Kinds of Artificial Foundation, and of the Midribs of Comb Built upon Each.

Very Heavy Foundation		Medium Brood Foundation		1898 Deep-Cell Foundation*			Thin Super Foundation		Extra Thin Foundation		† 1899 Deep-Cell Foundation		Midribs of Natural Worker Comb
Entire Foundation	Midribs of Comb on	Entire Foundation	Midribs of Comb on	Entire Foundation	Midribs of Foundation	Midribs of Comb on	Entire Foundation	Midribs of Comb on	Entire Foundation	Midribs of Comb on	Entire Foundation	Midribs of Comb on	
H. 12.	10.10	8.80	6.87	5.55	2.55	4.10	4.20	3.70	3.64	3.12	5.12	3.74	3.20
L. 10.	7.00	8.10	3.50	5.38	2.40	3.00	4.00	2.40	3.53	2.75	4.44	3.33	1.65
Ave. 11.	8.00	8.40	5.18	5.46	2.50	3.44	4.07	3.00	3.60	2.95	4 50	3.23	2.10
Heavier Than Natural Midrib.	5.90	—	3.08	—	.40	1.34	—	.90	—	.85	—	1.12	—

The accompanying table gives, in the upper line, the heaviest weights found; in the second line the lightest weights; and in the third line the average weights, computed from a good number of examples in each case. The excess in weight above that of the midrib of natural worker comb is given in the bottom line.

The differences in weight between these foundations and the midribs of comb built upon them do not represent the weight of the wax removed from the midrib of the foundation by the bees, as the foundation has short cell walls which are also thinned. These may be seen by looking at illustrations of sections of foundation in Plates 2 and 4. It will be seen by the table that none of the comb built on foundation has a midrib as light as that of the natural worker comb, though, in some cases, the midribs of comb on thin and extra thin super foundations and on the "1899" deep-cell foundation are but little heavier than those of natural comb.

It will also be noticed that, while the midrib of the "1898" deep-cell foundation itself was but little heavier than that of natural worker comb, the comb built upon this foundation had a midrib much heavier than that of the natural. The reason for this will be given directly. The table also shows that the heavier the midrib of the foundation, the heavier will be the midrib of the comb upon the foundation. This would be a general rule that might have exceptions.

* This foundation was obtained for experiment in 1898, when it was comparatively a new product, so I have called it "1898" deep-cell foundation to distinguish it from the foundation mentioned below.

† Samples of this foundation were first received in 1899, and I have designated it the "1899" deep-cell foundation to distinguish it from the preceding.

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The above table shows that the very heavy foundation gave a comb midrib weighing 5.90 grains more to the square inch than the midrib of natural comb. Medium brood foundation gave a midrib 3.08 grains heavier to the square inch, or almost two and one-half times the weight of natural midrib. The lightest midribs were obtained by the use of extra thin and thin super foundations, averaging but .85 to .90 grains to the square inch more than natural midrib.

The use of the "1898" deep-cell foundation manufactured by Mr. E. B. Weed gave rather surprising results. The midrib from the foundation, before it had been worked over by the bees, averaged but .40 grains to the square inch more than the natural midrib, while the midrib of comb built on this foundation weighed 1.34 grains more. The midrib of this foundation was not uniform in thickness, in some places being thinner and in others thicker than in natural comb, as shown in Plate 4, Fig. *d*. Where the midrib was thick there was little or no thinning by the bees, but where it was very thin they reinforced the weak places by "plastering" on a quantity of wax. These thickened places are plainly shown at *n*, Fig. *c*, and at *f* of the plate just mentioned; and at *b* of Plate 1, and account for the increased weight of the comb midrib. Fig. *f*, just mentioned, is from one of the worst samples I have seen. Natural midrib is shown at *e*.

The difference in weight between the heavier artificial foundations and the midribs of the comb built upon them is too great to result from the thinning of the short cell walls alone, and can only be accounted for on the supposition that the bees do remove wax from the midribs of these foundations. The examination under a microscope of any heavy foundation that the bees have just begun to work will show the marks of their mandibles in the wax. At first the wax is left very rough, as shown in Plate 1, Fig. *g*, considerably magnified. At *h* is shown the smooth bottoms of the finished cells on the same foundation, which was medium brood in both cases.

To be convinced that heavy foundations have their midribs thinned, but not thinned to correspond with the midribs of natural comb, the reader has only to look at the figures in Plate 2. At *a* is shown a section of heavy foundation, and at *b* and *g* are shown midribs of comb built on this foundation. The lower third of *b* is a midrib of natural comb built on the foundation. At *c* and the lower end of *d* are shown sections of the medium brood foundation, while the upper portion of *d* and all of *e* show to what extent the midrib of this foundation was thinned. Notice also in this connection, that the full thinning of both foundation and cell walls is accomplished while the walls are yet quite short.

The fact that foundations are thinned was also shown by actual

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measurements. A large number of *plaster casts of comb on different foundations and of the foundations themselves were made, and then cut in different directions as shown in Plates 2 and 5. This made it possible to cut the wax of the different cells so that the thickness could be measured. A large number of measurements were made and tabulated, but the variations are so great in thickness of both midribs and cell walls in all kinds of comb that I have thought it not worth while to include the table here, but will state the general results.

† The common range in thickness of the midrib in naturally built worker comb was found to be between .08 and .16 millimeters.‡ In drone comb the common range was between .12 and .20 millimeters. None of the midribs of comb built on artificial foundations averaged as thin as the natural midrib in worker comb. In some cases those from thin and extra thin super foundations, and the "1899" deep-cell foundation approximated it closely. Where the midrib of a foundation is not thicker than about .17 millimeters, the bees seem not to thin much if any, though they go over the surface with their mandibles and scrape it so that it loses its tranparency.

It was also noticed that the midrib of any comb was thicker near its attachment, at the top, sides or bottom, than at some distance from these attachments. Illustrations of this may be seen in Plates 2 and 3. Fig. *c* of the latter plate shows a cut through the comb of a pound section made from side to side.

The heavier midrib and cell walls in drone comb are necessary to give it the same strength as worker comb, because the larger the cells the fewer the number, and the smaller the amount of wax required to build them to a given thickness.

Sections of natural worker comb are shown at *b*, *c*, and *e*, and the lower halves of *a* and *g* of Plate 3. Drone comb is shown in the lower part of *i* in Plate 2, and in *f* of Plate 3.

The midrib of comb built on "1898" deep-cell foundation was very irregular in thickness, for the reasons already given, and averaged about the same as drone comb. See Plate 4, Figs. *c* and *f*. Medium brood foundation also gave wide variations in the amount of thinning.

At Plate 2, *d* and *e*, are two of the best thinned samples I have seen, though little drawn. At *f*, Plate 5, is a sample of fully drawn comb on this foundation which has the midrib thinned but little.

At *f*, Plate 2, is shown a section of super foundation obtained from Mr. Elliott, of Denver, and at *h* is a section through comb on

* I got this idea from Mr. E. R. Root, Editor of "Gleanings in Bee Culture."

† I have not found any samples of natural comb with as heavy cell walls as those shown on page 69 of "A, B, C of Bee Culture," Figs. 1 and 2.

‡ Reduce millimeters to inches by dividing by 25.

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this foundation. The midrib averages about .17 millimeters in thickness, or fully as heavy as the midrib in drone comb. The upper half of *i* in this plate is also on this foundation, and the midrib is rather heavier than the midrib of the drone comb which the bees built, shown in the lower half of the figure.

At *j* of Plate 2 is shown a section of thin, and at *l* of the extra thin super foundations. The two differ chiefly in that the former has rather heavy cell walls, while the extra thin has almost no walls. At *k* is a section showing partially drawn comb on the thin super foundation, and at *g*, Plate 5, is a sample of fully drawn comb on the extra thin foundation. It will be noticed that the midribs of the comb samples built on these foundations are in most cases nearly, if not quite, as thick as in the foundations themselves. At *a* of Plate 3 is a section through comb, the upper two-fifths of which was built upon the thin super foundation and the lower three-fifths is natural. The midrib of the foundation seems not to have been thinned at all, and contrasts plainly with the midrib of the portion that was built entirely by the bees, and also with the midribs of figures *b* and *c* of the same plate, both of which represent natural comb.

At *g* of Plate 4 is shown a section of the beautiful "1899" deep-cell foundation, as I have termed it, that is manufactured by Mr. E. B. Weed. At *h* of the same plate is shown comb slightly worked on this foundation, and at *a* of Plate 5 is shown fully drawn comb on the same. Here again it will be noticed that the midrib is scarcely if at all thinned, and is as heavy as that of drone comb.

The evidence thus obtained by measuring the thickness of the midribs of foundations and of the comb built upon them bears out the results obtained by weighing, namely, that heavy foundations have their midribs thinned some, usually much, by the bees when they build comb upon them; but these are not thinned, in any case, to the lightness of natural worker comb. If the midrib is not thicker than .17 millimeters—.068 of an inch—the bees thin it little if any; if the midrib is much thinner than the normal, the bees are likely to thicken it by the addition of wax, making it much heavier than in natural comb.

DOES THE USE OF ARTIFICIAL FOUNDATIONS RESULT IN THICKER CELL WALLS IN THE COMB?

It is evident that a slight thickening of the cell walls increases the weight of the comb more than the same thickening of the midrib. *Cheshire estimated that the area of the cell walls of worker comb one inch thick is fully ten times that of the midrib upon which they are built. If this be true (and the difference in area is

* "Bees and Bee-keeping," Vol. II., page 213.

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greater when the comb is more than an inch thick), then the thickening of the cell wall by .01 of a millimeter increases the weight of comb one inch thick as much as thickening the midrib .10 of a millimeter.

The thickness of the cell walls is much less than that of the midrib. In natural worker comb I have found it varying between .045 and .07 of a millimeter, with an average of not more than .06 of a millimeter (.0024 of an inch). It has been thought by some that, though the bees may leave a heavy midrib in comb built on foundation, they will thin the cell walls down to the thickness in natural comb.

Although the cell walls of a large number of sections of comb have been measured under the camera of a compound microscope, it is difficult to give these in tabulated form, as there is so much irregularity in thickness. The heaviest part, except the extreme outer end, is close to the base of the cell, and the thinnest is beyond the middle of its length. Where comb on heavy foundations was studied, the bases of the cells were found to have distinctly thickened walls for some distance out, and this thickening was often quite irregular, as may be seen at *o* in Figures *g*, *h*, and *i* of Plate 2, and Figure *b* of Plate 4.

None of the foundations used in the experiment gave as delicately thin cell walls as are found in natural worker comb, except the thin and extra thin super foundations and, possibly, the rather shallow deep-cell foundation put out in 1899, which was placed upon the market by the A. I. Root Co., and which is being sold quite largely this year. I was not able in many cases to detect by measurements that the cell walls on these foundations exceeded the average thickness in natural comb. The difference, if any, is very slight. Figure *g* in Plate 4 shows the thickness of the cell walls of this foundation in cross section, and at *b* of Plate 5 is shown a section of the walls parallel to the midrib and quite close to it. Figure *a* of Plate 5 is a section of fully drawn comb on this foundation, and it will be seen that the cell walls have nearly, or quite, the delicacy of those in natural comb.

The "1898" deep-cell foundation with considerably longer cell walls, as shown at *d* of Plate 4, was not nearly so well worked according to my measurements. This may be due to the fact that the walls are so high that the bees cannot reach to the bottom with their mandibles to take hold of them and pinch them to the natural thinness They can only thin the lower portion of the walls by scraping them. As a rule, I have found the lower portion of the cell walls of comb on this foundation as thick as those built on the very heavy foundations, while in some cases they have been thinned very nearly to the delicacy of the walls in natural comb. A good illustration of the latter case is shown at the upper half of *a* of Plate 4, but even this sample compared with natural worker comb

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shows a difference in favor of the latter which is hardly noticeable in the photographic reproduction. On the other hand, the illustrations of sections of cell walls on this foundation shown at *d*, Plate 3, and at *c* and *f*, Plate 4, show plainly the abnormal thickness of the inner third or half of the cell walls as compared with the walls in natural comb shown in *b*, *c*, and *e* of Plate 3. In fact, a close inspection will show that in many cases the walls of the comb cells seem not to be thinner than the walls in the cells of the foundation before the bees have touched them. In all cases, with this foundation, I have found the walls of the comb cells thicker than in natural worker comb. At *i*, Plate 5, is shown a portion of Figure *d*, Plate 3, somewhat magnified. Notice the thickness of the cell walls in their basal portion.

The cell walls in Figure *h* and the upper half of *i* of Plate 2, and the upper third of *g* in Plate 3, were built on the foundation shown at *f* of Plate 2. The foundation, it will be seen, is almost without walls, yet the bases, at least, of the cell walls in the comb can be seen by the unaided eye to be sensibly thicker than in the natural comb samples.

It seems, then, that keeping the wax out of the cell walls does not entirely remedy the tendency to build heavier bases to the cell walls when plenty of wax is at hand. I do not have a test, however, on strictly "no-wall" foundation, but cannot think the case would be different than in the use of this foundation with such slight walls.

The medium brood and the very heavy foundations also gave cell walls decidedly thicker than those found in natural comb. Examples of cell walls on medium brood foundation are shown at *d* of Plate 2, and at *f* of Plate 5. In the two first mentioned figures the walls are made thinner than in the long drawn cells of the last named example. All are heavier than in natural comb.

At *g* of Plate 2 and *b* of Plate 4 are shown examples of comb on the very heavy foundation. In both cases the greater thickness of the walls is very plainly seen. In the first mentioned figure the heavy walls extend, plainly, the entire length of the cells. Compare with sections of natural comb cells in Plate 3.

These studies indicate that it is a mistake to make very deep cells in artificial foundation, unless their walls can be brought down to the thinness of the naturally built cell walls—which is probably impossible—otherwise, the bees will leave them thicker than in the natural comb. The only cell walls that were brought, practically, to the thinness of the natural comb were those built on foundations with a light base and with little wax in the cell walls. The deep cells may be of advantage in other ways, but not in getting a light comb for section honey.

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COMPARATIVE WEIGHTS OF NATURAL COMB AND COMB ON ARTIFICIAL FOUNDATIONS.

There is a third method of studying the effect of foundations upon the resulting comb which, to my mind, gives the most convincing evidence. By this method pieces of natural comb and comb on different kinds of foundation were cut into blocks of known area and carefully weighed. Then the cell walls were removed from the midribs and the weight of these two portions determined separately. Then the weights of the midribs and cell walls of natural comb were compared with the corresponding parts of comb built on artificial foundations, and the midribs of the latter with their corresponding foundation midribs. In this way I was able to determine whether the cell walls or the midribs of comb on artificial foundations were as light as in the natural comb.

Table Giving Weights, in Grains to the Square Inch, of Whole Comb and of the Midribs and Cell Walls of the Comb, in Each Case Separate.

Kind of Foundation.	Thickness of Comb.	Weight of Comb.	Weight of Midrib.	Weight of Cells.	Sq. ft of Comb to make 1 lb. of Wax.
Natural Worker Comb.....	1.87	13.00	2.20	10.80	3.74
" " "	1.85	12.90	2.50	10.40	3.76
" " "	1.83	12.20	2.20	10.00	3.99
" " "	1.25	12.80	2.30	10.50	3.80
" " "	1.25	10.90	2.20	8.70	4.46
" " "	1.20	9.50	2.00	7.50	5 12
" " "	1.18	9.60	2.15	7.45	5.09
" " "	1 15	9.55	1.80	7 75	5.09
" " "	1.13	9.55	2.33	7.22	5.06
" " "	1.00	10.00	2.50	7.50	4 86
" " "	.90	9.00	2.00	7.00	5.40
" " "	.90	7.60	1.80	5.80	6.40
" " "	.80	7.00	1.80	5.20	6.94
" " "	.75	6.60	1 90	4.70	7.37
" " "	.66	6.40	1.75	4.65	7.60
" Drone "	.93	10.75	3.55	7.20	4.52
" " "	.90	11.25	3.50	7.75	4.32
" " "	.88	9.90	2.80	7.10	4.91
Extra Thin "	1.25	11.90	2.75	9.15	4.08
" " "	1.22	10.61	2.33	8.28	4.58
" " "	.73	7.15	3.12	4.03	6.80
" " "	.60	7.15	3.07	4.08	6.80
Thin Super (A) "	1.25	13.00	2 40	10.60	3.74
" " " "	1.25	11.50	2.60	8.90	4.23
" " " "	1.20	11.50	3.00	3.50	4.23
" " " "	1.00	10.20	2.80	7 40	4.77
" " " "	.25	5.80	2.70	3.10	8 38
" " (B) "	.90	11.50	4.00	7.50	4.23
" " " "	.75	9.40	3.30	6.10	5.17
" " " "	.75	9.35	2.90	6 45	5.20
" " " "	.75	9.10	2.70	6.40	5.34
1898 Deep Cell "	1.46	16.80	3.60	13.20	2.89
" " " "	1.44	16.63	3.70	12.93	2.92
" " " "	1.13	14.90	3.30	11.60	3.26
" " " "	.56	10.25	3.40	6.85	4.74
" " " "	.50	10.00	4.00	6.00	4 86
1899 " " "	1.50	14.50	2.83	11.67	3.32
" " " "	1.31	13.33	3.33	10.00	3.65
" " " "	.75	11.51	3.74	7.77	4.23
" " " "	.31	6.00	3.00	3.00	8.10
Medium Brood "	1.30	19.50	6.87	12.63	2.49
" " "	1.20	19.12	6.12	13.00	2.54
" " "	1.06	16.50	6.23	10.26	2.95
" " "	1.00	16.50	5.50	11.00	2.95
" " "	.75	12.00	5.35	6.65	4.05
" " "	.75	13.00	5.20	7.80	3.74
" " "	.38	7.50	3.50	4.00	6.48
*Very Heavy "	1.00	18.50	7.00	11.50	2.63
" " "	.95	18.88	8.00	10.38	2.65

* This line is an average of pieces composing 15 square inches of comb.

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In the preceding table all the weights obtained from the pieces of comb are given.

The first fifteen examples in the table are of worker comb as built by the bees in the natural way. The three following are naturally built drone comb.

The extra thin foundation weighed but 3.60 grains to the square inch, or 13.50 square feet to the pound, and had very slight cell walls. It is shown at *l* of Plate 2 in cross section.

The foundation listed as "Thin Super (A)" weighed almost exactly four grains to the square inch, or a trifle more than twelve square feet to the pound, and was rather firm in texture. It is shown in cross section at *j* of Plate 2.

That listed as 'Thin Super (B)" was of the same weight as the preceding, but of softer texture and had more wax in the midrib and less, almost none, in the short walls. It is shown in cross section at *f*, Plate 2.

The "1898" deep-cell foundation is the kind shown at *d* of Plate 4. It ran about 5.46 grains to the square inch, or approximately, nine square feet to the pound.

The "1899" deep-cell foundation is that shown in Figure *g* of Plate 4, and it weighed 5.10 grains to the square inch or 9.53 square feet to the pound.

The medium brood foundation weighed 8.40 grains to the square inch, or 5.80 square feet to the pound. It is shown at *c* of Plate 2.

The very heavy foundation averaged 11 grains to the square inch, or 4.42 square feet to the pound, and is shown at *a*, Plate 2.

The thickness of the comb samples in each case is given in the second column in the table, and is stated in inches and hundredths.

The third column gives the weights in grains to the square inch of the samples used, and is the sum of the weights in columns four and five, which give the weights of the midribs and the cell walls respectively.

The column at the right gives the number of square feet of each sample of comb that would be required to weigh one pound.

Each sample was of whole comb, *i. e.*, comb drawn to a greater or less thickness but not capped, so that the cells were complete as built.

It would have been better, or at least easier, to compare samples of comb of the same thickness; but comb varies so much in this respect that it was found impossible to do so with the samples at hand in the experimental apiary, and the evidence desired seems to be fairly ample in the data obtained and given in the preceding table.

First, I will call attention to the fact that the three samples of drone comb, varying between .88 and .93 of an inch in thickness,

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are considerably heavier than samples of natural worker comb of approximately the same thickness.

The sample of comb 1.25 inches thick on extra thin super foundation is but .10 of a grain heavier than the average of the two samples of natural comb of the same thickness. The sample 1.22 inches thick is fully as light in proportion to its thickness. The two thinner comb samples on this foundation do not compare quite as favorably with the natural.

The thickest sample of natural comb measured 1.37 inches, and weighed 13 grains to the square inch. No sample on artificial foundation as thick weighed so little, while one sample 1.25 inches thick on thin super foundation (A) weighed the same. All samples over .75 of an inch thick on medium brood and very heavy foundations weighed from about one-fourth to two-thirds heavier, or from 16.50 to 19.50 grains to the square inch. The sample 1.13 inches thick on deep-cell foundation put out in 1898 exceeds in weight the thickest sample of natural comb by 1.9 grains to the square inch.

The samples of natural comb 1.34 and 1.33 of an inch thick are also exceeded in weight by the same thinner samples of comb on artificial foundations just mentioned.

The heavier sample of natural comb measuring 1.25 inches thick is exceeded in lightness by one sample of comb on thin super foundation of the same thickness, while the other sample of the latter is heavier than the natural.

The two thickest samples of comb on "1898" deep-cell foundation average one-seventeenth thicker than the thickest sample of natural comb, but their weights average more than one-fourth heavier than those of the latter. Their comparsion with the next two samples of worker comb would be still less favorable to the foundation.

The sample of natural comb measuring 1.13 inches thick seems not to be unusually light, as the sample 1.15 thick weighed no more; the one that was 1.18 thick hardly exceeded it, and the one 1.20 thick weighed even less. Comparing this comb with the sample of the same thickness on the "1898" deep-cell foundation, we find the latter is heavier than the former by more than one-half the weight of the natural comb. In other words, it is heavier than the natural comb by almost exactly the weight of the deep-cell foundation. The two samples of comb on this foundation that are .60 and .56 of an inch thick respectively are as heavy or heavier than any of the samples of natural worker comb measuring from 1.20 inches in thickness down.

The "1899" deep-cell foundation produced a comb much nearer the natural in lightness. Comparing the sample 1.50 inches thick with the natural sample 1.37 thick, we see there is but 1.50 grains difference in weight, which would be fully accounted for by the greater

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thickness of the comb in the case of the latter. Comparing with the two thickest samples of comb on the "1898" deep-cell foundation, either of which is thinner than the "1899" sample, we notice that the latter is, nevertheless, considerably lighter in weight.

If we compare the sample of comb 1.31 inches thick on the "1899" deep-cell foundation with the samples of natural comb measuring 1.33 and 1.35 inches respectively, we find a good margin of difference in favor of the natural samples, although they are somewhat thicker than the example on foundation.

These comparisions bring us again to the conclusion that, of the samples of foundation that we have studied, the thin and extra thin super, and the "1899" deep-cell foundations, are far the best for the production of a comb to compare in quality and lightness with natural comb.

* Now, if we examine columns four and five we shall see that the increased weights of the examples of comb on artificial foundations were due more to the extra wax in the cell walls than to the increased amount of wax in the midribs in cases of the heavy foundations, but not in cases of the thin and extra thin super, or "1899" deep-cell foundations. I will call attention to a few examples and the reader may compare others.

Beginning with the heaviest foundations first, it will be seen that the comb cells in the sample one inch thick weighed 11.50 grains, against 7.50 grains in the case of the natural comb of the same thickness. In case of comb one inch thick on medium brood foundation, the cells weighed 11.00 grains to the square inch.

Take the samples of the same kinds of comb that are .75 of an inch in thickness and the weights of cell walls are, for natural comb, 4.70 grains; for comb on medium brood foundation, 6.65 grains; and for comb on very heavy foundation, 7.80 grains. It will also be noticed that the two samples of comb on "1898" deep-cell foundation that were less than .75 of an inch thick had cell walls that were considerably heavier than the natural comb that was of that thickness.

If we combine the two samples of medium brood comb, one measuring 1.30 and the other 1.20 inches thick, we shall have an average of a sample 1.25 inches thick, the cells of which weigh 12.81 grains to the square inch. Comparing this with the weights of the cells of the natural comb samples of the same thickness, we find it exceeds the heavier by 2.31 grains, and is almost one and one-half

* In "A, B, C of Bee Culture," p. 67, Mr. E. B. Weed is reported to have discovered "That in ordinary foundations upon the market, there was too much wax in the base (midrib) and not enough in the wall; that whenever the base is thicker than the bees make it they will rarely take the trouble to thin it down; but, no matter how thick the wall, they will invariably thin it down to the thickness of the natural." Both these statements need to be much modified, according to the experiments here reported.

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times the weight of the lighter. It even exceeds the weight of the thickest of the natural comb samples by 2.01 grains.

If we take the comb cells on "1898" deep-cell foundation that measured 1.13 of an inch thick and compare their weight with the sample of like thickness of natural comb, we see that the cells of the latter are lighter by 4.38 grains. In fact the cell walls of this sample of deep-cell foundation exceed in weight any of those of the seven thicker samples of natural comb.

The comb samples on the "1899" deep-cell foundation had cell walls that compare very favorably with the natural comb in lightness. The comb 1.31 inches thick on this foundation had cells that weighed exactly the same as cells of natural comb that was 1.33 inches thick, and the cells from the sample 1.50 inches thick did not weigh more than would be expected for natural comb. The sample of comb .75 of an inch thick on this foundation does not compare so favorably in weight of its cells.

If we pass to the comb on thin super foundations we again find very satisfactory comparisons. The cells from comb 1 inch thick and from comb 1.20 inches thick weighed only a trifle more from the foundation than from natural comb. The same is true of the average of the two samples in each case that were 1.25 inches thick. The differences being so slight, go to show that there is practically no difference in the weight of cell walls of natural comb and comb of the same thickness on the thin super foundation.

The samples of comb on extra thin foundation compare equally well with natural comb in the lightness of their cell walls, as may be seen by the table.

By comparing the weights of the comb midribs given in column four, it will be seen that the lightest midribs from comb on foundation are not quite as heavy as the heaviest midribs in natural worker comb, but in every case they are heavier than the average weight (2.10 grains to the square inch) of the midrib of natural comb.

With this additional evidence, it seems impossible to avoid the conclusion that heavy foundations result in combs heavier than the natural, and that the increased weight is due both to thicker midribs and heavier cell walls, but much more to the latter than to the former in cases where heavy foundations are employed, even though much wax is left unused in the midrib.

The experiments show that to get a light comb, approaching that which the bees naturally build, there must not be a large amount of wax in either the midrib or cell walls of the foundation.

The evidence is also quite conclusive that if the cell walls are very high, as in the "1898" deep-cell foundation, they will not often be well thinned in the building of the comb.

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TO WHAT EXTENT DOES THE FOUNDATION LESSEN THE SECRETION OF WAX BY THE BEES?

Let us begin with the comb built on the heavier foundations and compare with the naturally built worker comb, to determine the effect on wax secretion.

Natural worker comb 1 inch thick weighed 10.00 grains to the square inch. The very heavy foundation alone weighed 11.00 grains, or 1 grain more than is necessary to build the comb to that thickness. But when comb was built on this thick foundation, it weighed 18.50 grains, so that the bees added 7.50 grains to the square inch to the foundation that itself contained more wax than was necessary to build the comb. As natural comb weighs but 10.00 grains to the square inch, the bees lacked but 2.50 grains of furnishing as much wax as they would have done if they had built the comb without the foundation. *It is seen that 11.00 grains of wax were furnished the bees in order to save them the expense in food and labor of producing 2.50 grains.

In case of the medium brood foundation weighing 8.40 grains to the square inch, the result was similar. The bees needed to add but 1.60 grains to this to build the comb one inch thick, but they did add 8.10 grains, making a comb weighing 16.50 grains to the square inch. As the amount added in this case is only 1.90 grains less than the weight of the natural comb of the same thickness, it cost the whole weight of the foundation, or 8.40 grains, to save the bees from secreting 1.90 grains of wax.

As another illustration with this same foundation, take the samples drawn to .75 of an inch. The average weight would be 12.50 grains. This is 5.90 grains more than the weight of samples of natural comb drawn to the same thickness, and 4.10 grains more than the weight of the foundation alone, notwithstanding the fact that the foundation as given the bees contained 1.80 grains to the square inch more wax than was necessary to build natural comb to that thickness. In other words, the bees were furnished more wax than was necessary to build the comb three-quarters of an inch thick, and yet they added to this amount more than nine-tenths as much wax as they would have used to build the comb without foundation.

Passing now to the Weed deep-cell foundation manufactured in 1898, we find results fully as surprising. If we compare the sample measuring 1.13 inches thick with natural comb of the same thickness, we find that the latter is lighter by 5.35 grains. As the foundation itself weighed only 5.46 grains to the square inch, the indication is that the bees used as much wax from their own secret-

* Cheshire says "Bees very rarely work more than half their cell walls out of even the stoutest sheets given them."—*Bees and Bee Culture*, V. II., p. 216.

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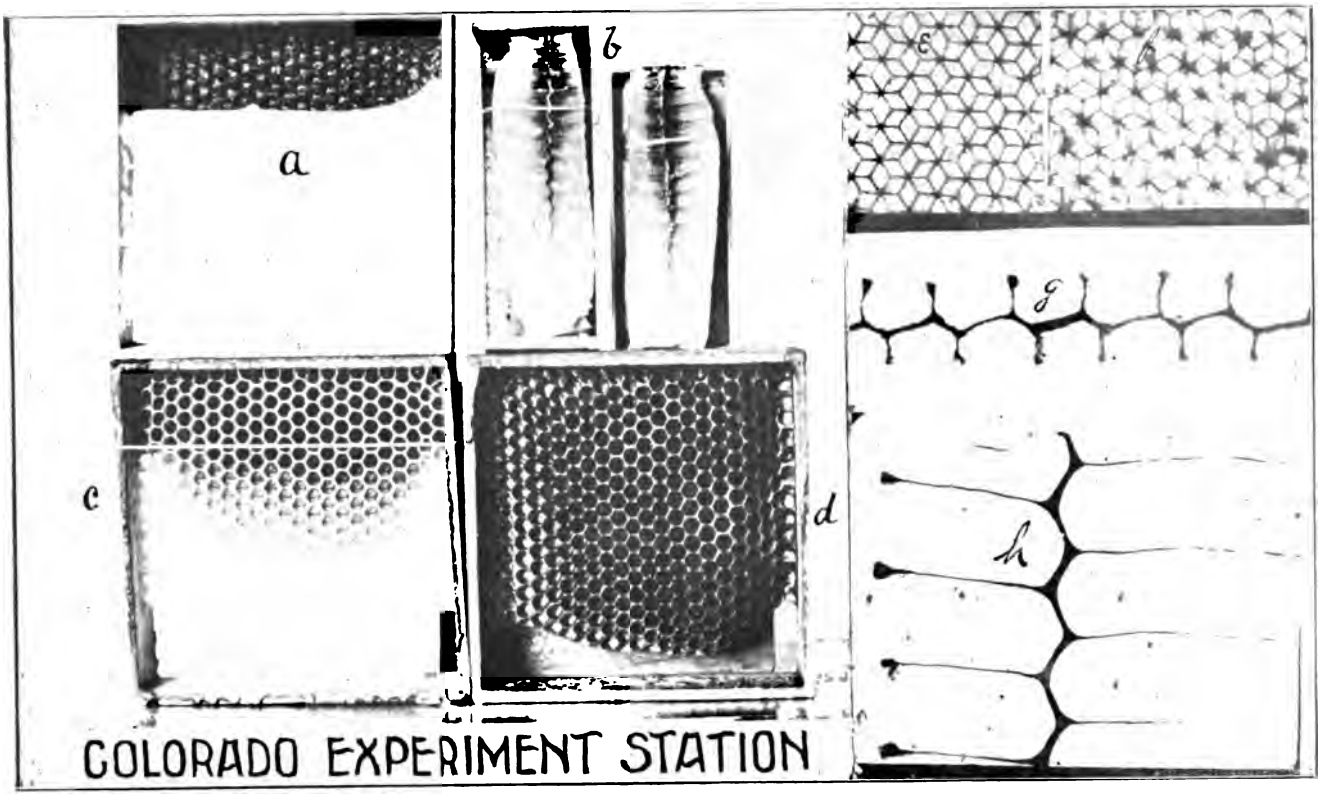

PLATE 1.

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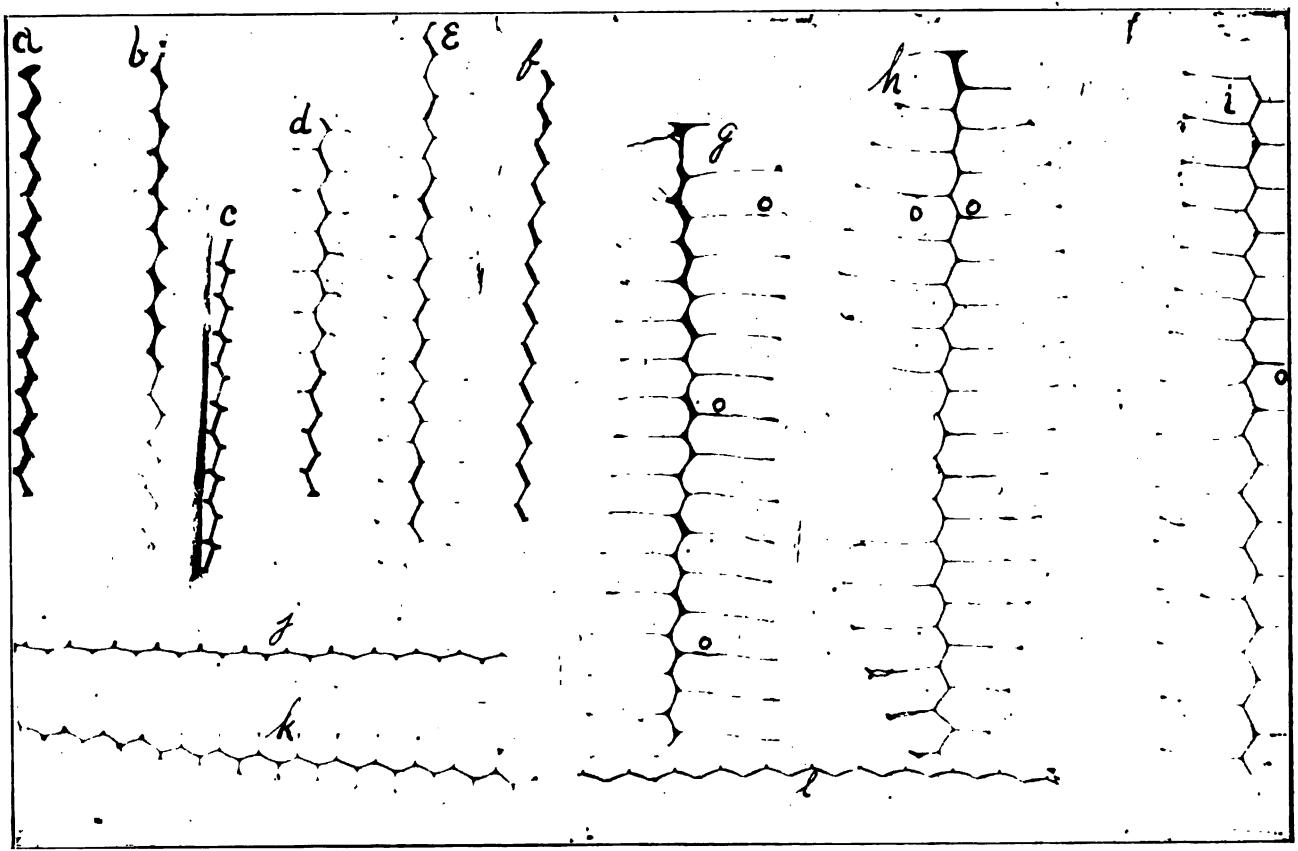

PLATE 2.

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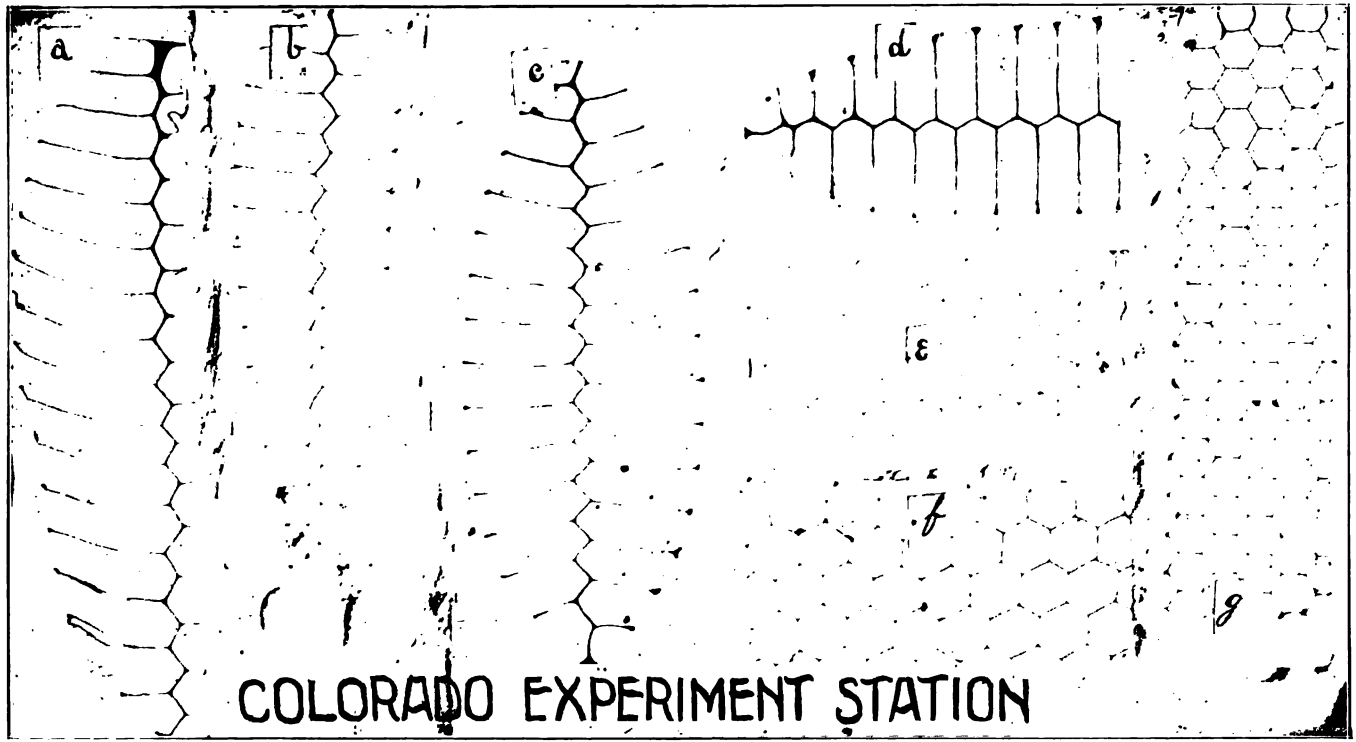

PLATE 3.

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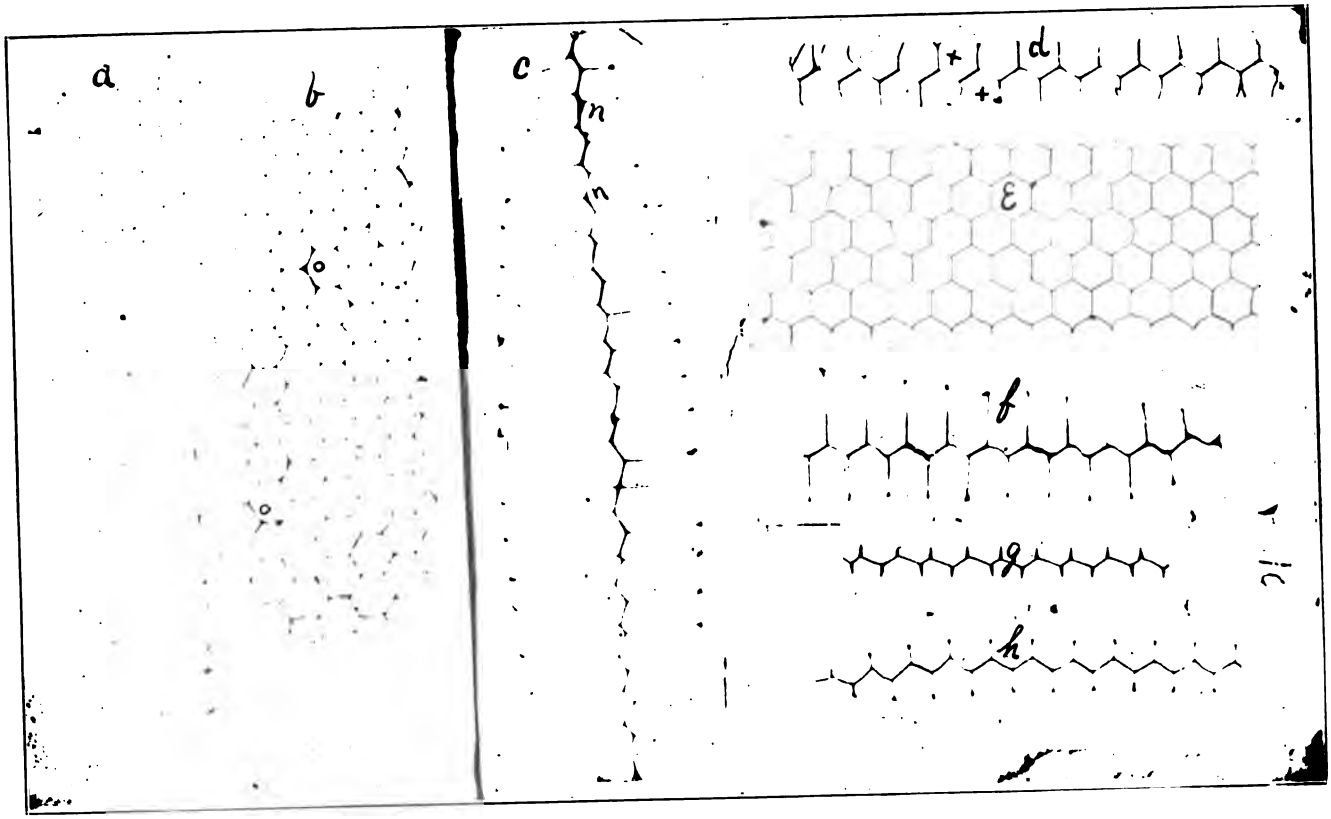

PLATE 4.

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ing within .11 of a grain, as they would have done if no foundation had been given.

The samples of comb .56 and .60 of an inch thick on this foundation contain enough wax to make a natural comb one inch thick, and nearly half of the weight was added by the bees.

Reliable results are not so readily obtained in the study of comb samples on the light foundations, as the amount of wax in them is small and the natural variation in comb samples is considerable.

The thickest sample on the thin super foundation (B) was only .90 of an inch. To get as near an average weight of the natural comb as possible for comparison, let us combine the two examples that measure .90 of an inch each with those measuring respectively 1.00 and .80 of an inch. The average would be 8.40 grains to the square inch. The difference between this and the sample on this foundation is 3.10 grains. As the foundation itself weighed 4.00 grains to the square inch, the indication in this case is that the saving to the bees was the difference between these weights, or .90 of a grain to a square inch, or about 23 per cent. of the amount of wax given.

Far better results were obtained in the use of thin super foundation (A), the average weight of which was 4.07 grains to the square inch.

Comparing comb 1 inch thick on this foundation with natural comb of the same thickness, we find, in case of one of the samples in the table, there is but .20 of a grain difference in favor of the latter. This means that this foundation lessened the amount of wax that the bees secreted, by 95 per cent. of its own weight.

The above may have been rather an exceptional piece on the thin foundation. If we compare the sample that measured 1.20 inches in thickness with a similar sample of natural comb, we find a difference of 2 grains to the square inch. As the foundation was almost exactly twice this weight, it indicates that the bees were relieved from secreting an amount of wax equal to half the weight of foundation given.

It is important to notice that to build the comb on this foundation to the thickness of 1.20 inches, the bees added the difference between 11.50 and 4.07 grains to the square inch, which would be 7.43 grains, and this is actually less than they added in cases where they built comb to a thickness of only one inch on the very heavy and the medium brood foundations, and to a thickness of 1.13 inches on the deep-cell foundation, though in any one of these last three cases they were furnished more wax to start with.

Again, if we take the average of the two samples of comb on this thin foundation that were 1.25 inches thick and compare it with an average of the two samples of natural comb of the same thickness, we find that the latter is .40 of a grain lighter to the square inch

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than the former. This would indicate that 90 per cent. of the foundation was utilized by the bees in making a comb but slightly heavier than the natural. We also find that the bees actually added less to this foundation in order to draw it out to 1.25 inches in thickness than in cases where they built comb to a thickness of an inch on the heavy and medium brood foundations. Further experiments are needed bearing upon this point.

If we compare the comb built on the "1899" deep-cell foundation and the extra thin super foundation with the natural comb, we find results nearly, or quite as good as the preceding. For examples, the comb 1.31 inches thick on the deep-cell foundation was but 1.13 grains heavier than the natural sample 1.33 inches thick, and the sample on this foundation that was 1.50 thick exceeded the weight of natural comb 1.37 inches thick by only 1.50 grains.

In case of the comb on extra thin foundation, the sample that was 1.22 inches thick weighed but 1.11 grains to the square inch more than the natural sample that measured 1.20 inches thick; and the sample on this foundation 1.25 inches thick is almost exactly an average of the two pieces of natural comb of the same thickness.

It seems, then, from all the evidence furnished by the forty-nine samples of comb listed in the preceding table, that we do not lessen the wax secretion of the bees much, if any, more when we furnish them a heavy foundation than when we furnish them a very light foundation.

These differences between the heavy and light foundations for comb building seem quite remarkable, and in a large series of samples might not result so much in favor of the light foundations; but the samples recorded in the table were taken without any attempt or thought of favoring one form or weight over another.

The writer believes it is a matter of much importance to beekeepers to produce comb honey with as small an amount of wax as possible. They will, in this way, increase the consumption of their product, as many people object to comb honey because of the large amount of wax they often find in it.

METHODS OF USING FOUNDATION IN SECTIONS.

It is necessary to use some foundation in sections for comb honey. The best size and form of the piece of foundation to be used as a "starter" is not universally agreed upon, some preferring one form and some another.

The different methods of applying these starters, shown in Figures *a* to *g* of Plate VI., have been tested in the College Apiary for the past three years.

There was no appreciable difference in the comb produced by using starters in the manners shown by Figures *a*, *c* and *d*. The only advantage in the long, narrow piece, shown at *e*, was that it had

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a tendency to secure the building of worker comb throughout. It has one disadvantage, and that is its large size and short line of attachment, so that if it is not well secured at the top the bees are liable to cluster upon it and pull it loose. The long, narrow piece placed across the top of the section, Figure *f*, has given rather better results than any of the preceding, as the bees usually attach it quickly at the ends, thus closing the top corners. I have also used many starters like the preceding, but extending about half way down. Figures *h*, *i* and *j* represent comb on such starters. It will be noticed there are no holes in the upper corner or sides. At *n* is a section of comb built on a full-sized starter, as shown at *g*. It will be noticed that the comb cells are all uniform in size and the comb evenly filled out. Such comb when filled and capped, is handsome in appearance, like the samples shown at *s*, and brings the highest market price. In my experiments the sheets that extended half way down gave as good results as those that filled the section. The use of small pieces of foundation in the lower corners, as shown at Figure *c*, gave no beneficial results.

The use of short strips of foundation in the middle of the bottom of the section, as shown at *b*, has resulted in somewhat better attached combs at the bottom of the section, especially during a slow honey flow.

Figures *k*, *l* and *m* show how comb is usually extended from a small piece of foundation, leaving, very often, holes in both upper corners. If the honey is coming in slowly and the colony is not very strong, the sections are liable to be finished like the two shown at *o* and *p* of the same plate. Not only are these sections light in weight and slow to sell, but they will not ship well, for the jar of handling will break many from their attachments in the sections. I have found, however, that such sections of honey are due much more to a weak condition of the colony and a poor honey flow than to the manner of using foundation. Under such conditions even large pieces of foundation are often gnawed away, as shown at Figures *q* and *r*. When the colony is strong and the honey flow good, small pieces of foundation, like the one shown at *a*, will often produce just as finely filled sections as can be obtained from full-sized pieces with strips below. Moral: Keep the colonies strong.

Comb built upon foundation is always tougher and more waxy than the natural comb, and a cross-section will show that the midrib and bases of the cells are darker in color. So that while the large pieces of foundation result in a somewhat finer appearing capped honey, the small starters will result in a more delicate and brittle comb.

ADVANTAGES FROM THE USE OF SEPARATORS.

Most producers of comb honey recognize the advantage in the use of thin strips of wood or tin between the rows of sections in the

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supers. Without them the comb is sure to be uneven in a large proportion of the sections, and in many cases it will be bulged so as to make it very difficult to pack the sections in a crate for shipment. Illustrations of such sections are shown at *h* of Plate 5. These sections also vary much in weight, some weighing considerably more than a pound, while others weigh as much less. They are not as attractive nor as easily handled upon the market as those that are built with flat faces that do not project beyond the edges of the section, and that are all uniform in weight and appearance, as shown at *s* of Plate 6. I have used the tin and board separators in about equal numbers and have been unable to see that one has any special advantage over the other.

I have also used separators upon one side and upon both sides of the sections. While very good sections of honey are obtained by the use of separators upon one side only, the results have been enough better when used upon both sides to make the latter plan advisable. In my experiments the sections that had no separators averaged one-half ounce more in weight than those with separators on one side only, and the latter weighed one-half ounce more than the sections that had separators on both sides. As these lighter, better appearing sections sell better than the heavier, ill appearing ones, there is a double advantage in their production.

PROPORTION OF WAX IN COMB HONEY.

Beeswax does not melt at the temperature of the body and is indigestible in the human stomach. Although this does not necessarily imply that beeswax is harmful in food, it becomes a matter of some interest to know how much wax is taken with ordinary comb honey when the latter is eaten. It is also a matter of interest to know how much wax the bees are compelled to secrete for every pound of honey that they store in the natural way.

As a thick comb has but one midrib, and as the walls of the cells are heavier near the midrib than they are towards their outer portions, it is evident that comb one and one-half inches thick would not be half heavier than comb one inch thick. The increased weight of the thicker comb would be due entirely to the additional wax required to extend the walls of the cells one-half inch, and to that only. On the other hand, it is equally evident that the honey filling a comb one and one-half inches thick would weigh half more than honey filling a comb one inch thick. Consequently the weight of wax in thick combs is less in proportion than in thin combs. The weights given in the following table shows this to be true:

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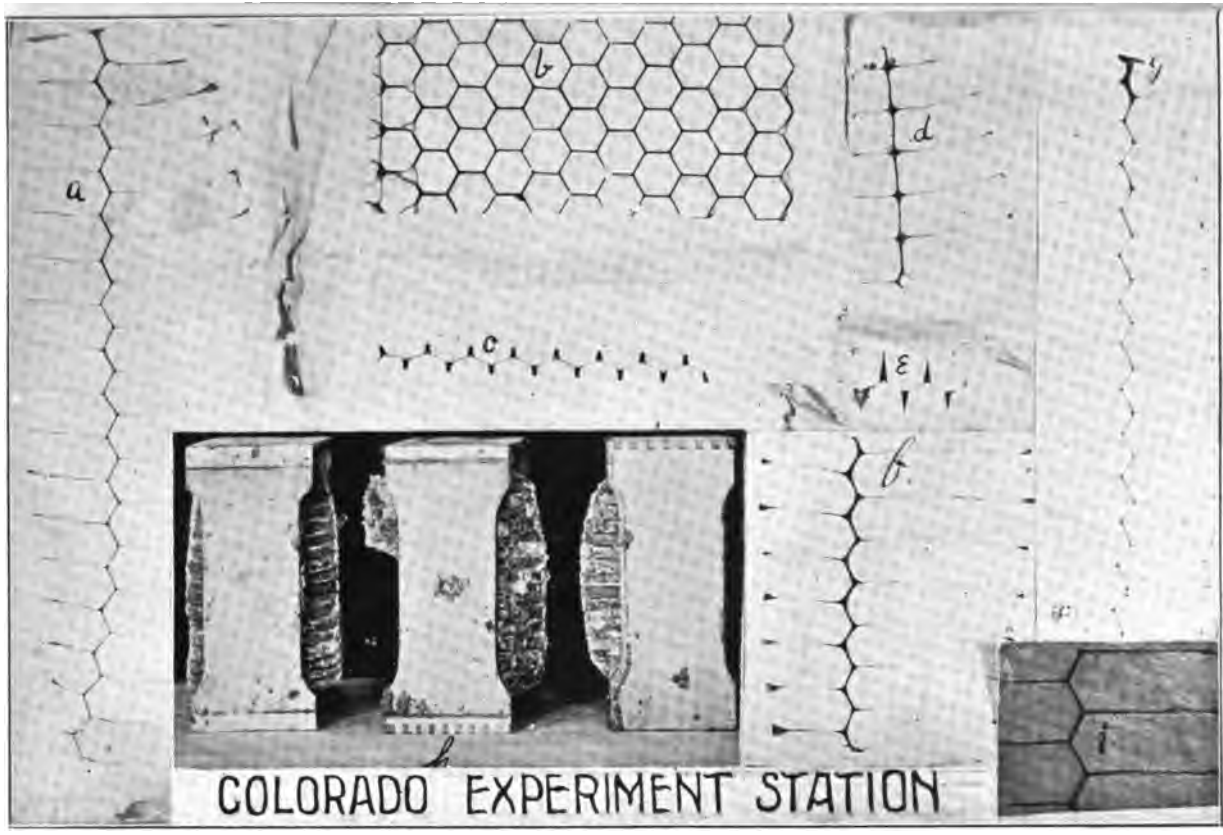

PLATE 5.

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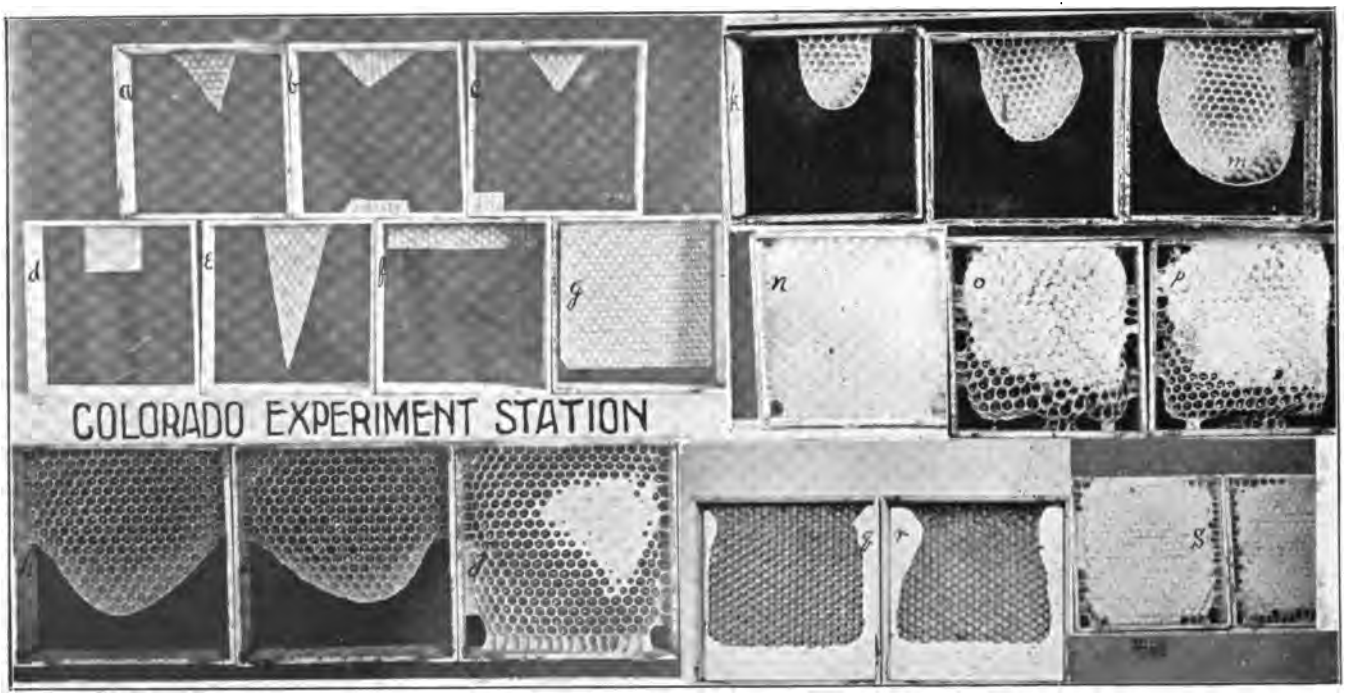

PLATE 6.

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Table Giving the Proportionate Weights of Honey and Wax in Capped Comb Honey.

KINDS OF COMB.	Thickness in Inches.	Total Weight in Grams.	Weight of the Honey in Grams.	Weight of Wax only in Grams.	Proportion of Wax to Honey.
Natural	1.37	308.45	297.95	10.50	1 to 28.38
"	1.13	174.00	167.71	6 29	1 to 26.66
"	.75	75.00	71.14	3.86	1 to 18.43
On Small Starter	....	374 00	356.76	17.24	1 to 20.70
" " "	....	351.00	334.40	16.60	1 to 20.02
" " "	....	346.00	330.40	15.60	1 to 21.12
" " "	....	344.20	328.50	15.70	1 to 20.92
" " "	....	344.00	328.19	15.81	1 to 20.76
" " "	....	312.80	298.00	14.80	1 to 20.13
" " "	....	287.00	273.20	13.80	1 to 19.80
On Full Piece '99 Deep-Cell Starter	.. .	544.00	525.08	18.92	1 to 27.75
On Full Piece '98 Deep-Cell Starter	....	404.00	384.00	20.00	1 to 19.70

In case of natural comb honey 1.37 inches thick the honey weighed 28.38 times as much as the wax, while the sample .75 of an inch thick, which was built at the same time as the thicker comb and by the side of it, had only 18.43 times as much honey as wax. The intermediate sample (1.13 inches thick) had 26.66 times as much honey as wax.

All other comb samples in this table were taken from sections measuring $4\frac{1}{4}$x$4\frac{1}{4}$ inches and $1\frac{7}{8}$ inches thick. The combs were built on small top starters, except in case of the last two examples, one of which was built upon a full-piece of the "1899" deep-cell foundation and the other upon a similar sheet of "1898" deep-cell foundation. The thickness of the comb was not taken in these sections, but it did not vary much from one and one-fourth inches in any case.

The comb in the sections with small starters did not vary much from one-twentieth of the weight of honey in any case, and the proportion of wax was somewhat greater than in the samples of natural comb of similar thickness.

Passing to the sample of comb on the "1899" deep-cell foundation, we notice, first, that it is much heavier than any of the preceding, and hence much thicker, and in consequence it has a much higher ratio of honey to wax, 1 to 27.75. This is also in keeping with results announced on previous pages, indicating that this

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foundation is drawn out by bees into a comb approximating the lightness of the natural product.

In contrast to this last example, but also in harmony with results given on preceding pages, notice that the "1898" deep-cell foundation gave a comb heavier than the preceding, though the honey weighed less by more than one-fourth. The proportion of wax to honey was greater in this case than in any of the others, except that of natural comb only .75 of an inch thick. It should have given a larger proportion of honey than any of the samples built on small starters, as the comb in the latter was thinner in every case.

From the facts given in the above table, it is evident that if we are to secure a comb honey with the least possible amount of wax, it will be necessary to have it built in sections that will secure the greatest thickness of comb. In this way we can also economize very considerably the labor and energy of the bee in wax secretion and comb building.

Attention might also be called to the fact that it takes more wax and more work for the bees to cap ten pounds of honey in thin comb than in thick comb.

The reader will not understand that I am advocating the use of deep sections; there may be other reasons why they are not preferable; I am only mentioning points which, according to my experiments, favor thin sections.

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SUBSTITUTES FOR POLLEN.

It is a well known fact among bee-keepers that bees can be stimulated to early brood rearing in spring by putting out some kind of finely ground meal or flour, which they take as a substitute for pollen. Writers vary in their opinions as to what is the best, but it is commonly recommended to use rye, oats, or pea meal. Common wheat flour, wheat middlings, corn meal, barley meal, and malt all have their advocates. It was thought best to put out at one time a good number of these substitutes for the purpose of determining which would be given the preference by the bees. To do this a number of boards were laid flat upon the ground in the vicinity of the apiary, a small pile of each kind of meal put upon them and notes taken upon the results.

It was found that any of the substances used would be taken freely when used alone. Also that the preference did not always go to the same feed.

Results with the first series of tests were published in the Seventh Annual Report of this Station. As that report did not reach a large number of general readers, and as subsequent tests lead to some change in the order of preference, I have thought it best to report upon the work again here. The order of preference as nearly as could be judged ran as follows: Ground whole kernels of oats, corn, and wheat, fine wheat bran,* cleaner dust,† cotton-seed meal, wheat bran, pea meal, wheat flour, rye flour, bean meal, barley meal. The three last named they would hardly touch as long as others were accessible.

As pollen furnishes the bees with nitrogenous food, it seems probable that those substitutes for pollen that have most nitrogen, or rather, that furnish the chemical compounds most nearly in the proportions that they are found in pollen, would be best suited to take the place of pollen in the dietary of the bee.

In order to determine whether or not the chemical composition of the food-stuffs best liked by the bees were more like the composition of pollen than the others, I had a quantity of corn pollen col-

* Bran ground over so as to be fine.

† Waste dust and chaff as taken from cleaners at flouring mill.

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lected and taken to Dr. W. P. Headden, Station Chemist, for analysis. In the table below the first analysis is that of corn pollen made by Dr. Headden, and the analyses of the other materials are compiled :

NAME.	Water.	Ash.	Crude Fibre.	Fat.	Protein.	Nitrogen Free Extract.
Corn Pollen	3.444	5.039	7.970	1.526	19.598	62.423
Oats Ground	9.3	3.5	8.5	3.6	11.4	63.7
Corn "	13.6	1.4	1.9	3.4	9.6	70.1
Wheat "	11.5	2.0	2.9	2.0	12.1	69.5
Wheat Bran	11.0	5.7	10.4	5.0	15.9	52.0
Cotton-seed Meal	8.0	6.9	6.7	10.0	43.0	25.7
Pea Meal	8.8	2.6	17.7	1.6	19.2	50.1
Wheat Flour	12.6	0.7	0.7	1.2	11.8	74.1
Rye Flour	14.0	1.6	1.5	1.6	10.5	72.5
Bean Meal	12.0	1.4	2.1	8.5	11.0	65.0
Barley Meal	13.1	2.4	5.7	1.9	11.3	65.6

It will be noticed that, while the nitrogenous material (protein) is high in the pollen, it is not very high in some of the flours best liked by the bees, as for example, corn and oats. Cotton-seed meal runs very high in protein and was not specially liked.

So there are, doubtless, other reasons than the amount of nitrogenous food material, that influence the bees to take substitutes for pollen. It is probable that the aroma and mechanical qualities may have much to do in determining their choice. There is nothing very definite in the above order of choice of the different foods used. The order will often vary on consecutive days, or even on consecutive hours.

It is by no means certain that the flour the bees like best is best for them, for this manner of supplying them nitrogenous food is entirely artificial. The best substitute for pollen is that food which the bees will take and upon which they do best, and it seems probable that it will have a chemical composition approximating that of natural pollen.

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SUMMARY OF MORE IMPORTANT CONCLUSIONS.

1. Bees use freely the wax in foundation to extend both the midrib and the cell walls of honey comb.

2. The heavier the foundation used, the heavier, as a rule, will be the comb built upon it.

3. If the midrib of a foundation is much lighter than that of natural comb, the bees are likely to strengthen it by adding wax to the bottom of the cells.*

4. If the midrib of the foundation is thicker than the midrib of natural comb, it will result in a comb with a midrib thicker than the natural. Or, to state it differently, the bees will not thin the midrib of a foundation down to the thickness of worker comb built in the natural way.

5. Midribs of foundation that are not more than .17 of a millimeter (.007 inch) in thickness, are thinned little or none by the bees.

6. Drone comb has a thicker midrib and heavier cell walls than worker comb.

7. A foundation with a heavy midrib and very slight cell walls, will still produce a comb with heavy cell walls.

8. Very high cell walls in foundation are not cut down to the thinness of cell walls in natural comb.

9. The thin and extra thin and the "1899" deep-cell foundations produce a comb that approximates very closely the lightness of that which is naturally made by the bees.

10. When heavy foundations are used, the extra weight of the comb built upon them is due more to the extra weight of the cell walls than to the heavier midrib.

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* Possibly this is only done where there are actual perforations of the comb.

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11. When very light foundations are used, the somewhat heavier comb is due almost entirely to the midrib being heavier than that of natural comb.

12. When foundations containing an abundance of wax to build the entire comb are used, the bees still add much more wax, sometimes nearly enough to build the comb without the help of the wax in the foundation.

13. Wax seems to be given with the best economy when the midrib of the foundation is of the thickness of the midrib of natural comb, and when there is a small, or at most a moderate, amount of wax in the cell walls.

14. Poorly attached combs in sections seem to be more the result of weak colonies and poor honey flow than to the kind of starter that is used; though large starters and strips of foundation in the bottom of the sections do help to strengthen the union of comb to the section.

15. Separators between the sections are essential to the best results in producing comb honey.

16. The thicker the comb, whether natural or artificial, the greater the proportion of honey to wax in it.

17. In natural worker comb, one inch thick, the proportion of wax to honey is between 1 to 20 and 1 to 25 by weight.

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EXPLANATION OF PLATES.

PLATE 1.

a, blackened super foundation; *b*, sections of comb built on a strip of blackened foundation as shown at *a*; *c*, comb built on narrow strip of foundation as shown at *a*; *d*, fully drawn comb built on full-piece starter of black foundation; *e*, midrib of natural worker comb after removing the cells; *f*, midrib of comb built on "1898" deep cell foundation; *g*, comb that the bees have just begun to draw on medium brood foundation, enlarged about two diameters; *h*, like the preceding except that the cells are fully drawn.

PLATE 2.

a, cross-section of very heavy foundation; *b*, midrib of comb built on very heavy foundation in upper two-thirds, the lower third being natural midrib extended by the bees; *c*, cross-section of medium brood foundation; *d*, like the preceding except that the bees had begun to draw out the cells in the upper two-thirds of the figure; *e*, the same as *d* with the cells farther drawn; *f*, a rather heavy super foundation blackened with lamp-black; *g*, section of comb on heavy foundation shown at *a*; *h*, comb on foundation shown at *f*; *i*, the upper two-fifths like *h* and the remainder natural drone comb; *j*, section of thin super foundation; *k*, the same as the preceding with the cells partly drawn; *l*, section of extra thin foundation.

PLATE 3.

a, section of comb on thin foundation in upper half, natural comb in lower half; *b*, natural comb; *c*, natural comb cut from side to side of a section of honey; *d*, comb built on "1898" deep-cell foundation; *e*, cells of natural worker comb cut in cross-section; *f*, cells of natural drone comb in cross-section; *g*, cells of worker comb in cross-section, the upper one-third of which was built on the foundation shown at *f* of Plate 2, and the rest is natural.

PLATE 4.

a, cross-section of comb cells, the upper third of which were built on "1898" deep-cell foundation; *b*, cross-section of worker

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comb built on very heavy foundation; *c*, section of comb built on "1898" deep-cell foundation; *d*, section of "1898" deep-cell foundation; *e*, cross-section of the cells of "1898" deep-cell foundation before being worked by the bees; *f*, section of comb on the "1898" deep-cell foundation; *g*, section of "1899" deep-cell foundation; *h*, partly drawn comb on the preceding foundation.

PLATE 5.

a, section of comb on "1899" deep-cell foundation; *b*, cross-section of cell walls of the "1899" deep-cell foundation before they have been worked at all by the bees; *c*, section of the Weed "thin-base-and-heavy-wall" foundation; *d*, section through comb to show that the midrib can be cut so as to give a straight line; *e*, another sample of comb manufactured by Mr. Weed with extremely thin midrib and high and heavy walls; *f*, comb on medium brood foundation; *g*, comb on extra thin super foundation; *h*, sections of honey showing how comb is bulged when separators are not used; *i*, comb on "1898" deep-cell foundation somewhat magnified, showing the heavy basal portion of the cell walls.

PLATE 6.

a to *g*, different methods of using starters in sections; *h*, *i* and *j*, showing how comb is built on starters that fill the sections half way down; *k*, *l* and *m*, showing method of building down comb from small starter; *n*, comb built on a full-piece starter; *o* and *p*, the way sections are finished in weak colonies or during a poor honey flow, particularly with small-piece starters; *q* and *r*, large piece starters that the bees have gnawed away during dearth of honey; *s*, the way sections should be finished.

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FORESTS AND SNOW

—BY—

L. G. CARPENTER.

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* Died December 9, 1900.

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FORESTS AND SNOW

By L. G. CARPENTER.

The intimate connection between the melting snow banks of the mountains and the agricultural prosperity of Colorado is too evident to those acquainted with the conditions of the State to need discussion, for most of the water which carries fertility to the fields and farms comes from the white-capped mountains; but even among those most interested in the agriculture of the State there have been some who have had a question as to the extent to which the forests were useful. Some have even advocated their destruction, under the supposition that the water supply would be increased.

While it is not thought by the writer that the forests materially affect the rainfall in our Colorado mountains, their influence as a protecting cover for the snow and in saving it from premature melting and the effect of winds, which increase the evaporation, is an important function. Without intending to enter upon a discussion of the question at this time, this bulletin is more especially intended to bring out some of the relations of the forests to our water supply, which have become evident in our study of one of the typical irrigation streams, and also to present some of them pictorially, in such form as to help the reader draw conclusions for himself.

For some years attempts have been made to obtain photographs which would show certain conditions, but as visits to the localities in question were usually made for other purposes, the trips were too late to be at the best time to examine the effect of the forests. It was found that it would be necessary to go earlier in order to obtain views desired, and to make trips for that special purpose. Hence, when the heavy snowfall of 1899 gave promise of remaining late enough in the summer to permit visits to the regions without interference with other work, advantage was taken of it. Correspondence had been opened with mountain friends, who with long acquaintance with mountain conditions had had unusual chances for observation. They were asked to let me know when the snow cover had so melted that the ground appeared in places, and also the places where green timber and bare spots were near together, so that the conditions could be readily compared. A portable dark-room was prepared for developing in the field. Reports that the conditions were favorable were received from three correspondents on the same day. The snow fields were melting so fast that only one section could be visited while the conditions were favorable, and this was near

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the headwaters of the Cache a la Poudre. Two places, some twenty mile apart, were visited. One on the divide between the Poudre River and Estes Park, and the other on the headwaters of the Laramie River. The former was visited under the guidance of Mr. John Zimmerman, who is a native of Switzerland, and who has lived in the high elevations of Colorado for nearly twenty years; the latter, under the direction of Mr. John McNabb, who has also had a long and intimate acquaintance with high elevations. The results are shown in the plates, which speak for the photographic skill and successful carrying out of instructions by Mr. J. D. Stannard, then assistant in the Department of Engineering. It is believed that no more striking series of photographs on this subject has been brought together. They enable a comparison of the conditions to be made by the reader and repay examination and thoughtful consideration in connection with the charts.

We hoped to obtain an additional series of photographs during the subsequent winter, but the character of the snowfall was unfavorable for this purpose.

A general description of the condition of the streams, as connected with the melting of the snows, is desirable as a basis for the explanation of the views.

CHARACTER OF THE STREAMS.

Colorado is moderately supplied with rain, the annual precipitation averaging about fourteen inches. In the mountain areas, the amount varies with the elevation and topographical conditions, but the increase with elevation is not marked until the extremely high elevations are reached. In these places observations are under exceptional conditions, and too few in number to form a safe guide. On the eastern slope of the mountains, the precipitation is mostly due to the easterly winds brought in by the passage of an area of low barometer to the south. The air is forced up by the mountain ranges, and cooled by the elevation enough to cause condensation and precipitation. Sometimes there are extremely heavy local showers, often called cloudbursts. Much of the precipitation at the higher elevations, even in the summer months, is in the form of snow. June, July and August are practically the only months in the year when rain falls at or above timber line. Snowfalls are not uncommon down to an elevation of 6,000 feet, even in May.

The rain runs off quickly and may immediately influence the streams. The snow remains until it is melted or evaporates. Its effect is gradual, and may thus last for some time. Most of the winter precipitation in the mountains remains on the ground in the form of snow until spring. A portion, sometimes not inconsiderable, evaporates, especially when the snow is porous or soft. It may then be seen to visibly decrease. Heavy winds which blow the snow about increase this loss. Some of the mountain observers say, "The wind just naturally wears it out."

In the case of land denuded of timber the surface is generally hard, and the water runs off rather than penetrates. In the forest areas the soil is looser, more porous and absorbent, and takes up water freely. In such areas springs, or springy soil, are more common, while they are

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rarely found in tracts burned over or denuded of timber. It is the water from these springs which maintains the flow of the rivers from September to April. Their decrease is cause for alarm. Within the past few years the Poudre at one time fell to less than forty cubic feet per second. April and May are the months of heaviest rainfall; most of the continued storms occur during these months. Yet, our river records, now carried on for nearly twenty years, show that these rains have comparatively little effect. A rise in the river due to a storm is distinguishable from one due to melting snow, as may be seen from the diagrams. The snows show a daily tide, usually at the same hour. The rises due to storms are irregular in time and character. An unexpected effect is that rains in the mountains usually decrease the amount of water. The cloudiness associated with the storms prevents more thawing than the rain supplies.

If the area covered by snow has been extensive and extends to a relatively low elevation, with the coming of warm weather the snow melts soonest on the low areas. As a rule these are less protected from the rays of the sun. Melting proceeds, even to considerable elevations, in the direct rays of the sun, though freezing may be going on at the same time in the shade, as on the north side of the ridges. A forest cover protects from the direct rays of the sun just as the ridges do.

In the middle of the summer, snow is to be found at moderate elevations only in the forests or under ridges where sheltered from the direct rays of the sun. As melting proceeds the tributaries are swollen, and the main streams increase in volume, their maximum being reached long before the greatest heat of summer. Though the melting is faster, the snow areas are so much less that the aggregate is reduced, hence, the stream decreases.

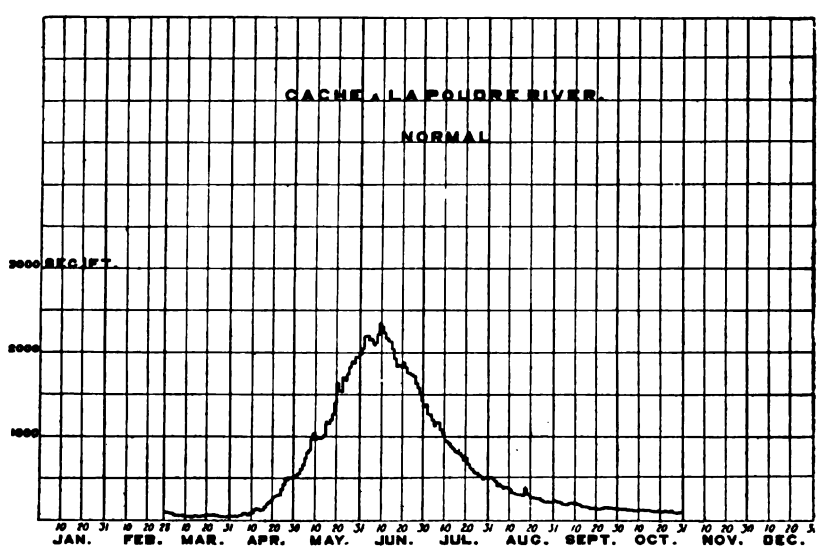

Figure 1.

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A typical stream is shown in Fig. 1. This represents the flow of the Cache a la Poudre, on which a longer series of records are available than on any other of the Western streams. The diagram is from nearly twenty years' record of automatic instruments.

The stream is low in fall and winter, when the supply is largely from springs. It rises in April with the rains or melting snows, and more rapidly as the sun and increasing temperature acts on the snow fields.

The rate of rise depends on the area which is covered with snow; on the temperature of night and day; on the dryness of the air, as affecting evaporation; the area of the forest! and the character of the snow, whether it be new and soft or old and hard.

DAILY EFFECT OF THE SUN ON THE MELTING.

A daily rise and fall takes place and is more marked as the river rises. This is shown by the various diagrams. Fig. 2 is a fac-simile of the diagram taken from the instrument during the week from June

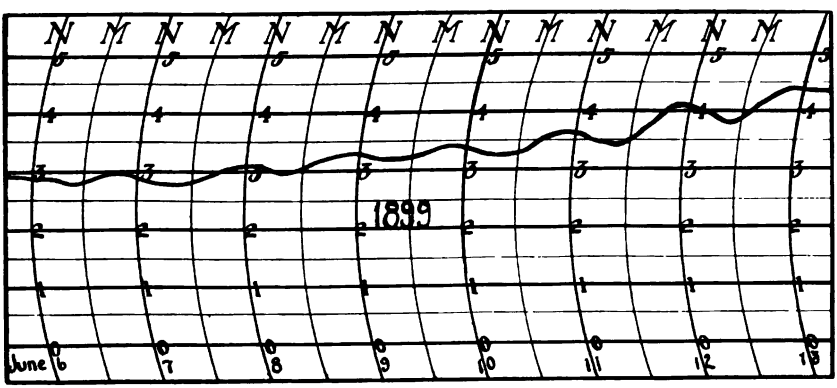

Figure 2.

6-13, 1899. The days are shown at the bottom of the diagram, the gage depths at the left. "N" indicates the noon hour, "M" midnight. The crests of the rises are seen to be twenty-four hours apart. The high water occurs from 4 to 6 a. m. at the point where our instrument is placed, and the low water about 8 p. m. This hour depends on the distance to the snow fields. An examination shows that the extreme fluctuation on June 20-21 was nearly a foot, less on the other days.

When we consider the quantity of water, instead of the depths, this fluctuation appears of more importance. Fig. 4 represents the quantity of water for the same week as shown in Fig. 2. The scale at the left gives the quantities in cubic feet per second. While on the evening of June 20 there was less than 3,000 cubic feet per second, before morning it had become 4,700 cubic feet, falling back to about 3,300 cubic feet during the day, and rising again to 3,900 feet during the night. This diagram is typical of the fluctuation in sunny weather

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during high water. The change is clearly connected with the diurnal effect of the sun. It is seen in the other diagrams, but almost disappears in cloudy weather.

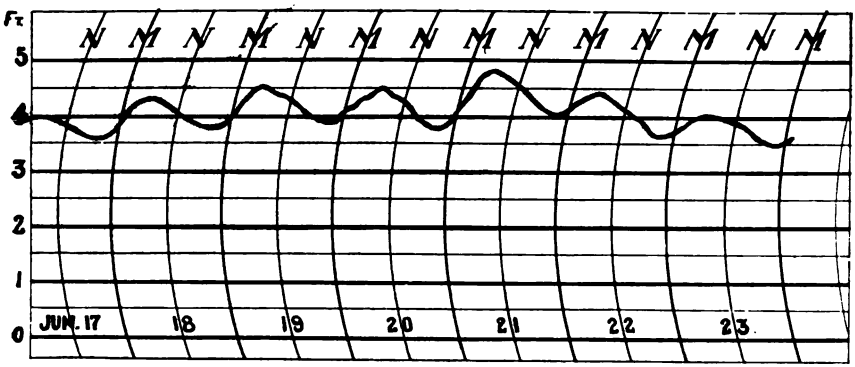

Figure 3.

While the temperature has a marked influence in determining the general stage of the river, the direct action of the sun as shown by the diagrams is still more marked, as it causes these fluctuations. Anything

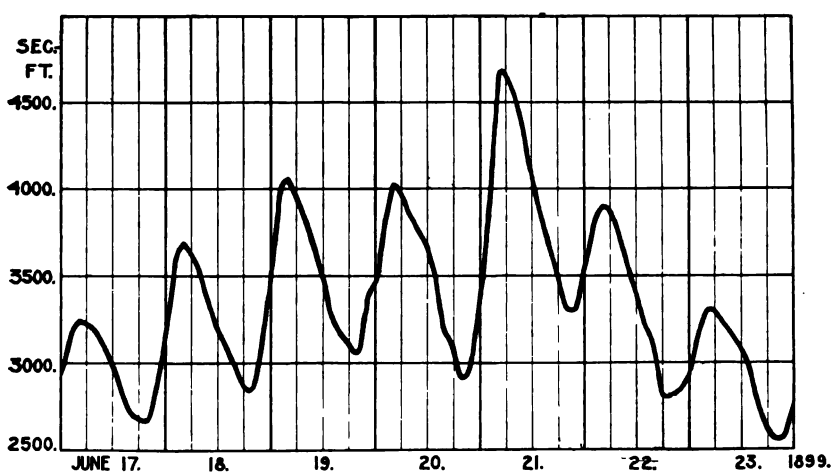

Figure 4.

which serves as a protection from the sun, whether forests, ridges, boulders or clouds, lessens the melting and tends to decrease these tides. This explains the paradoxical fact that a general rain in the mountains often lessens the amount of water in the river.

This effect is illustrated by Fig. 5, which shows the record of a rainy week in 1898. On June 1 the diurnal fluctuation was slight, on

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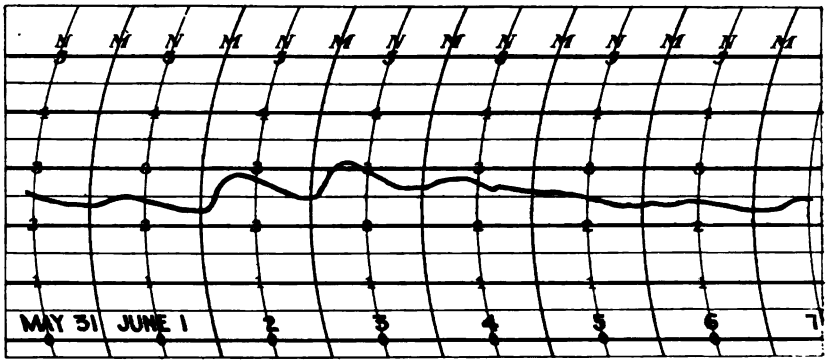

Figure 5.

June 2 it was more marked, and still more so on June 3. For the rest of the week it was scarcely noticeable. The days of June 1 and 2 were sunny, the two following days were rainy, and the rest of the week cloudy. On the night of June 3-4, 1.12 inches of rain fell at the Station, an unusually heavy rainfall, yet the river was lower after this rain than before. The clouds protected the snow from the sun, and this was of more effect than the exceptional rain.

Another record illustrating the effect of a general cloudiness, is for the last week in May, 1897, shown in Fig. 6. The flow for this week was

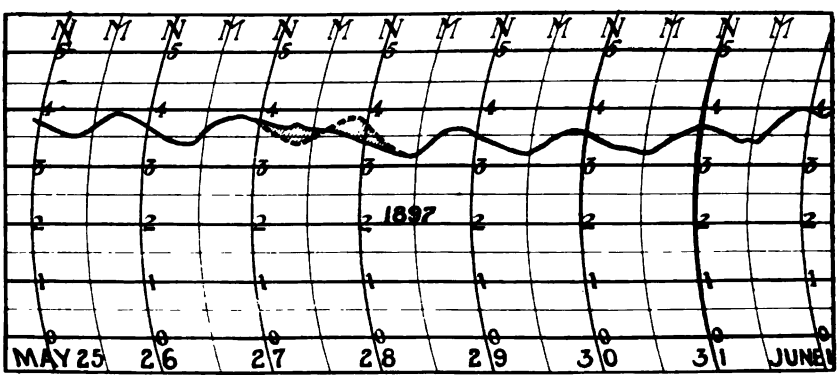

Figure 6.

normal, except on the 28th, when the river lacked the fluctuation evident on the other days. This was due to the character of June 27. It was cloudy and rainy all day at Fort Collins, and also over the whole watershed. The precipitation at the Station amounted to .28 in. There were hard showers near the river, as shown by the slight rise on the afternoon of the 27th. At Westlake, at an elevation of about 8,500 feet and about the middle of the watershed, the precipitation was .80 in. Notwithstanding this heavy rainfall the river shows a steady decrease. The dot-

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ted line shows the probable course of the fluctuation, as judged from the records of co-operating observers, had there been no storm and the weather remained clear.

The different effect of a local shower on the river is shown in Fig. 7. Two local storms are in evidence on this record; one on the afternoon of May 18, and the other beginning to show on the afternoon of May 20, with a marked rise during the night.

The storm of May 18 was a sudden violent shower over a small area. As it was near the river, the effect was very marked. The rain-gauge at the Station recorded only .03 in. A shower of .20 in. on May 19 does not show; but there was a storm on the night of the 19th and extending throughout much of the forenoon of the 20th, amounting to 1.28 inches. This was heavy in the mountains also, especially at the lower elevations. The effect is seen in that the river continued to rise on the morning of the 20th, instead of falling. The sudden rise about midnight was due to the access of the flood from one of the important tributaries.

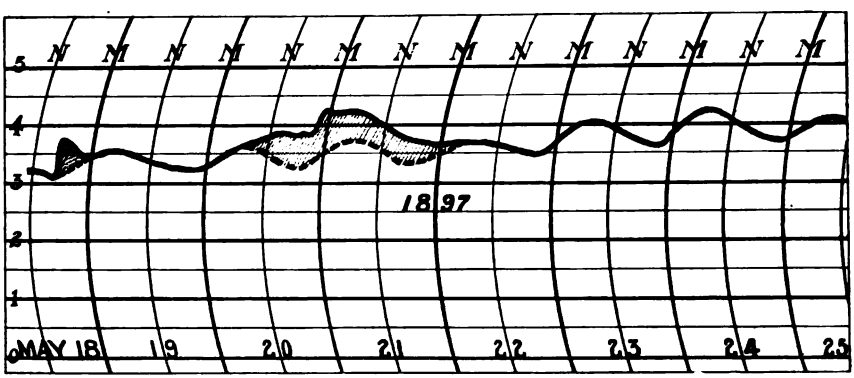

Figure 7.

The dotted line shows the probable fluctuation of the stream if there had been no storms. Neither of the storms extended to the higher elevations and did not cause general cloudiness, and the general course of the river was but little affected.

As snow is most evident on the high peaks, undue importance is attached to high elevations. The run-off from the forest fringes below timber line is of far more importance. The precipitation at the high elevations is not much, if any, more than at lower elevations. The rainfall on Pike's Peak, standing as it does on the edge of the Plains, cannot be considered representative of the other high elevations, and is undoubtedly much greater than that on other peaks equally as high. Even if a great amount of precipitation falls on the top, it is confined to a small area of relativey little importance. Thus, for instance, I have had occasion to examine the watershed tributary to the Rio Grande. While this has an area of 4,611 square miles above 8,000 feet elevation, there is less than 200 square miles of it above 12,000 feet, although this watershed has a large number of the highest peaks in the State.

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In this case, over 90 per cent of the watershed is below timber line and above 8,000 feet.

That the forests in the mountains increase the amount of precipitation does not seem probable, whatever their effect when on the plains or lands of low elevation may be. The precipitation in the mountains is mostly due to the cooling from expansion, caused by the air being forced upward by the mountains. The effect of the forests would be so small compared with the mountains that it does not seem possible that they would increase the amount of rainfall. It, however, is not impossible that in the maintenance of moist conditions, influence on the currents of air, and the protection of slopes from the burning rays of the sun, there may be an effect even on the amount and distribution of the rainfall. Nevertheless, they influence the river floods, and protect the snows from melting and the action of the winds. As a protection from floods, they form a feature which the agricultural interests of the State should jealously protect.

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CONCLUSIONS.

1. The mountain streams in the early irrigation season are largely supplied by melting snow.

2. There is a marked diurnal fluctuation, greater with high water than with low, due to the daily variation in the rate of melting.

3. The stream at high water may be one-half greater than at low water on the same day.

4. Cloudy weather in the mountains, protecting the snow from the radiation of the sun, causes the fluctuation to disappear and the flow to decrease.

5. This decrease is so great that the cloudiness associated with continued rain usually more than counterbalances the gain from the rain.

6. The loss of snow by evaporation is considerable, especially when exposed to winds.

7. Snow remains in the timber and in protected spots much longer than where exposed.

8. This is due not so much to drifting as to shelter from the radiation afforded by the forest cover.

9. Hence, the greater amount of forest cover the less violent the daily fluctuation, the more uniform the flow throughout the day and throughout the season, and the later the stream maintains its flow.

10. The loss of the forest cover means more violent fluctuation during the day, greater difficulty in regulating the headgates and keeping a uniform flow in ditches and hence an additional difficulty in the economic distribution of water. Also the water runs off sooner, hence the streams drop earlier in the summer and on account of the lessening of the springs, the smaller is the water flow.

11. The preservation of the forest is an absolute necessity for the interest of irrigated agriculture.

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PLATES.

PLATE 1.—11:30 a. m., June 21, 1899. Elevation about 9,600 feet. Looking southwest into dead timber. Medicine Bow Range in the distance.

PLATE 2.—11:40 a. m., June 21, 1899. Looking northeast into open white pine timber. Ground sloping gently to the northwest. Snow drifts from three to five feet deep.

PLATE 3.—3 p. m., June 21, 1899. Looking east. Plates 9, 10, 11 and 12 were taken near here. Mr. Zimmerman is shown on the drift.

PLATE 4.—11:00 a. m., June 21, 1899. Looking northwest, showing Mr. Zimmerman behind drift. Slopes to the northwest. Drifts hard. Elevation about 9,600 feet. Open white pine timber. Nos. 5 and 6 taken from this point.

PLATE 5.—11:00 a. m., June 21, 1899. Looking north from same point as No. 4.

PLATE 6.—11:20 a. m., June 21, 1899. Looking southwest into dead timber.

PLATE 7.—10:30 a. m., June 21, 1899. Snow in the open white pine timber. Slopes to the north. Nearest drift, 60 feet long, 48 feet deep, 15 feet wide. Snow granulated. Elevation about 9,600 feet. Looking southwest.

PLATE 8.—4:05 p. m., June 19, 1899. Near No. 13. Snowdrift in the distant green timber.

PLATE 9.—12 m., June 21, 1899. Looking southwest. Bare slope. Elevation about 9,600 feet.

PLATE 10.—1:30 p. m., June 21, 1899. Drift 10 feet deep in green timber. Usually no snow here after June 1st. About 200 yards in timber from points where Plates 1 and 2 were taken.

PLATE 11.—2:45 p. m., June 21, 1899. Snow drift in green timber. From same point as Plate 12. Looking east. Ground slopes to east. Drifts about 12 feet deep, solid. Same drifts as in plates. Elevation about 9,000 feet. Four miles back of Zimmerman's.

PLATE 12.—2:40 p. m., June 21, 1899. From the same place as Plate 11. Looking southwest through dead timber. Mount Cameron in the distance.

PLATE 13.—8:50 a. m., June 24, 1899. Looking north. Elevation about 10,000 feet. Headwaters of the Laramie River. Ground slopes to the south.

PLATE 14.—9:45 a. m., June 24, 1899. Looking southwest. Near No. 13. Spruce and balsam.

PLATES 15, 16, 17 and 18.—June 24, 1899. From same point. Elevation about 9,800 feet. These views overlap, and may unite into one view. No. 15, 9:45 a. m. In dead timber, looking west. On south slope. No. 16, 10 a. m. Looking northwest into green timber. No. 17, 10:15 a. m. Looking north at south slope, showing snow in green timber. No. 18. 10:15 a. m. Looking northeast. Snow in green timber, bare ground in dead timber. Showing edge of snow between dead and green timber.

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PLATE 1. From the same spot as Plate 2. Same date. Looking northwest.

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PLATE 2. Looking northeast into green timber. June 21, 1899.

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PLATE 3. Snow drift. June 21, 1899.

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PLATE 4. From same point as Plates 5 and 6.

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PLATE 5. On border between dead and green timber.

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PLATE 6. Looking into dead timber.

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PLATE 7. Snow-drifts in pine timber.

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PLATE 8. Distant snow drifts.

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PLATE 9. Looking southwest. Bare slopes.

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PLATE 10. Drift in green timber.

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PLATE 11. Looking east from same place as Plate 10.

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PLATE 12. Looking southwest into dead timber.

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PLATE 13. Snow in sheltered spots.

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PLATE 14. Snow in sheltered ravine.

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PLATE 15. Plates 16, 17 and 18 from same point. Looking west.

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PLATE 16. Looking northwest.

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PLATE 17. Snow in green timber looking north.

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PLATE 18. Looking northeast.

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The Agricultural Experiment Station

OF THE

Agricultural College of Colorado.

THE

BIRDS OF COLORADO

A Second Appendix to Bulletin No. 37

—BY—

W. W. COOKE

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FURTHER NOTES

ON

THE BIRDS OF COLORADO.

BY W. W. COOKE.

Since the publication in March, 1898, of the notes on Colorado birds that had been gathered the previous year, many additional notes have been secured. The largest number from any one source have come from a thorough study of the fine collection of Mr. Edwin Carter at Breckenridge. This collection represents the work of Mr. Carter for more than thirty years. Much of the material was gathered in the immediate vicinity of Breckenridge, and the rest in Middle Park and South Park. Breckenridge is at an altitude of 9,500 feet, while Middle and South Parks are from 7,500 to 8,500, so that Mr. Carter's collection is especially valuable as showing the bird life of the mountains and mountain parks. Breckenridge is on the western slope of the main range, and this collection furnishes several new records for the Pacific side of the mountains as well as a higher range than before known for more than thirty species. The Carter collection contains 184 species of birds, of which 127 are known to breed in Middle and South Parks. Mr. Carter has also taken 16 species that are not now in the collection. The collection adds two new birds to the state, *Ammodramus leconteii* and *Falco sparverius deserticolus*, and one new breeding record, *Wilsonia pusilla pileolata*.

Much space is given to notes from this collection, because the recent death of Mr. Carter makes the collection complete so far as his work is concerned. No catalogue or summary of this collection has ever been published. The present writer made three visits to Breckenridge, and has studied every bird in the collection at least twice. The last visit was but a few days before Mr. Carter left home on that last trip from which he was not to return alive. On this visit a complete investigation was made of all Mr. Carter's records of birds he had taken that are not now in

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the collection. This bulletin therefore presents the full work of Mr. Carter with reference to Colorado ornithology. Many of the notes from his collection add nothing new to our knowledge of the birds of the state, but are entered in order to make a complete catalogue of the species represented in the collection.

Most of the rest of the new notes come from the further investigations of Mr. C. E. Aiken, who has spent a great deal of time the past two years in collecting and studying the birds of the "Divide" and the plains east of Colorado Springs. From his own collecting he has added five birds to the Colorado list, and of two more he has obtained the records from other persons. One of the excursions of Mr. Aiken deserves special mention as showing the possibilities of Colorado ornithology. The days from May 19-27, 1899, he spent in the vicinity of Limon, about a hundred miles out on the plains east of Colorado Springs. A poor place for birds one would think, and yet while there he encountered what seemed to be a flight of eastern birds that had wandered from their usual course and strayed several hundred miles to the westward, and mingled with them some distinctively western species scarcely to be expected east of the mountains. The Red-bellied Woodpecker, Tennessee Warbler, Least Flycatcher, Red-bellied Nuthatch, Bobolink and Scarlet Tanager were rare visitants from the east found there, and in addition he took the Connecticut Warbler and the Canadian Warbler, both being the first records for Colorado.

In contradistinction to this highly successful trip, may be noted one taken by the present writer, which also shows the peculiar distribution of bird life in Colorado. About the middle of May he went from Fort Collins to Grand Junction. The latter place is about a hundred and fifty miles further south and five hundred feet lower than Fort Collins. Vegetation was at least two weeks in advance of the more northern location, but bird migration was apparently in just the same stage; being another instance of what is probably a general rule, that migration on a western slope is later than on an eastern. More surprising than this, however, was the character of the birds seen. Grand Junction is three hundred miles west of Fort Collins, on the Pacific slope and on the Grand river, that one would expect to find a natural highway for birds from the west and south. The country was quite carefully explored for twenty miles along the Grand and Gunnison rivers, and in all somewhat over forty different species of birds were identified. They were all common birds of the eastern slope, occurring at Fort Collins, except the Raven and the California Quail. The former occurs over all of

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western Colorado, while the latter has been introduced and has become exceedingly abundant. Out among the greasewoods, where greasewood is about the only vegetation that can grow, these Quail vie with the lizards as to which shall be the most common animal life present. In the whole trip not a distinctively southern or western species was observed, nor is there one in the list of sixty-one species of birds seen there by Miss Myra Eggleston during several years residence. The valley of the San Juan river serves as a great highway for southwestern forms into southwestern Colorado, and many extend along the Rio Grande into south central Colorado on the Atlantic slope, but apparently there is some conformation of land or condition of climate that keeps these forms away from west central Colorado.

The present bulletin is paged in continuation of bulletins Nos. 37 and 44, and references are to the pages of these bulletins. On page 3 the total number of species and varieties known to occur in Colorado should be changed to 387, of which 243 are known to breed. Thus in the three years since the Colorado list was published, 27 additions have been made and 15 more species ascertained to breed in the state. There is good reason to believe that the list, even now, is far from complete. A single fact will show how great are the future probabilities. In a small collection of beautifully mounted birds at Cheyenne, Wyoming, prepared by Mr. Frank Bond, are six species of birds taken by him at Cheyenne, less than ten miles from the Colorado line, that have not yet been found in this state. These species are *Sterna hirundo*, *Pelecanus fuscus*, *Crymophilus fulicarius*, *Ægialitis meloda circumcincta*, *Anthus spragueii* and *Cistothorus stellaris*, and there is every reason to believe that each of these will eventually be added to the Colorado list.

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CLASSIFICATION OF COLORADO BIRDS.

Changes to be made, including those already made on page 128 and pages 148-150.

Page 8. **1. Residents:** Add

Callipepla squamata.
Tympanuchus americanus.
Phasianus torquatus.
Falco sparverius deserticolus.
Syrnium nebulosum.
Coccothraustes vespertinus montanus.

Page 9. **2. Winter visitants.** Omit

Coccothraustes vespertinus montanus.

Page 10. **4. Species that have been taken in Colorado in winter, either as rare or accidental visitors.** Add

Gavia arctica.
Larus philadelphia.
Somateria dresseri.
Nyctala tengmalmi richardsoni.
Acanthis linaria rostrata.
Junco montanus.

Page 11. *B. Species that breed on the plains, but only to the foothills of the mountains.* Add

Philohela minor.
Callipepla squamata.
Tympanuchus americanus.

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Phasianus torquatus.
Syrnium nebulosum.
Phalænoptilus nuttallii nitidus.
Zamelodia ludoviciana.
Seiurus aurocapillus.
Harporhynchus bendirei.

Page 12. *C. Species that breed in the mountains or mountain parks and not on the plains.* Add

Falco sparverius deserticolus.
Coccothraustes vespertinus montanus.
Wilsonia pusilla pileolata.

D. Species that breed principally in the mountains. Add

Empidonax hammondi.

Page 13. *E. Species that breed regularly only in Southern Colorado.* Add

Plegadis guarauna.
Callipepla squamata.

Page 13. **6. Species taken in the State during the summer, but not known to breed.** Add

Gavia imber.
Aythya americana.
Charitonetta albeola.
Ardetta exilis.
Totanus flavipes.
Stellula calliope.
Astragalinus psaltria mexicanus.
Melospiza georgiana.

Omit

Plegadis guarauna.
Callipepla squamata.
Philohela minor.
Phalænoptilus nuttallii nitidus.
Seiurus aurocapillus.

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Page 13. **7. Migrants.** Add

Gavia adamsii.
Branta canadensis minima.
Porzana jamaicensis.
Astragalinus tristis pallidus.
Piranga erytbromelas.
Dendroica palmarum.

Omit

Harporhynchus bendirei.

Page 14. **8. Stragglers.** Add

Gavia adamsii.
Gavia arctica.
Somateria dresseri.
Branta canadensis minima.
Plegadis autumnalis.
Ardea egretta.
Porzana jamaicensis.
Nyctala tengmalmi richardsoni.
Bubo virginianus arcticus.
Coccyzus americanus.
Dryobates pubescens.
Stellula calliope.
Acanthis linaria rostrata.
Astragalinus psaltria mexicanus.
Ammodramus leconteii.
Melospiza georgiana.
Piranga erythromelas.
Dendroica palmarum.
Geothlypis agilis.
Geothlypis trichas.
Wilsonia canadensis.

Omit

Sylvania pusilla pileolata.
Harporhynchus bendirei.

Page 15. **10. Rare or irregular visitants, from the east or southeast.** Add

Branta canadensis minima.
Plegadis autumnalis.

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Ardea egretta.
Tympanuchus americanus.
Syrnium nebulosum.
Ammodramus leconteii.
Melospiza georgiana.
Zamelodia ludoviciana.
Piranga erythromelas.
Dendroica palmarum.
Geothlypis agilis.
Geothlypis trichas.
Wilsonia canadensis.

Page 16. **12. Rare or irregular visitants, from the west or southwest.** Add

Stellula calliope.
Astragalinus psaltria mexicanus.

Add the star (*) to denote breeding, to
Plegadis guarauna.

Page 16 **SUMMARY.**

Total species in Colorado	387
1. Residents	93
2. Regular winter visitants from the north	23
3. Regular breeders that sometimes occur in winter	17
4. Rare or accidental winter visitants	28
5. Summer residents	243
A. Breeding on plains and in mountains	101
B. Breeding on plains, but not in mountains	43
C. Breeding in mountains, but not on plains	56
D. Breeding principally in mountains, sparingly on plains	21
E. Breeding regularly only in southern Colorado	22
6. Summer visitants, not known to breed	18
7. Migrants	63
8. Stragglers	67
9. Regular visitants from east and southeast	14
10. Rare visitants from east and southeast	46
11. Regular visitants from west and southwest	20
12. Rare visitants from west and southwest	14

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BIBLIOGRAPHY OF COLORADO ORNITHOLOGY.

Page 21. Add. AIKEN, C. E. *Otocoris alpestris arenicola. Colorado Springs Gazette* (local newspaper), Feb. 8, 1899.

Habits of this bird during cold weather.

Page 22. Add. ANTHONY, A. W. A new subspecies of the Genus Dryobates. *Auk, XIII.* 1896, *p. 32.*

Describes the subspecies *Dryobates villosus montanus.* Rocky Mountain Woodpecker with the type from Boulder, Colorado. In *Auk, XV.* 1898, *p. 54,* Anthony changes *montanus* to *monticola,* and as such this subspecies has been recognized by the A. O. U.

Page 22. Add. BAIRD, S. F. Smithsonian Miscellaneous Collections, 181, Review of American Birds in the Museum of the Smithsonian Institution. Part I. North and Middle America. Washington Smithsonian Institution, 1864-66, pp. IV., 450.

Contains incidental records of a few species of birds taken in Colorado.

BANGS, OUTRAM. A Review of the Three-toed Woodpeckers of North America. *Auk, XVII.* 1900, *p. 126.*

Description of *Picoides americanus dorsalis,* with notes on nine specimens taken in Colorado.

Page 26. Add. BREWSTER, WM. Lewis's Woodpecker Storing Acorns. *Auk, XV.* 1898, *p. 188.*

Habits of the birds as noted near Denver, Colorado, and reported to him by Manly Hardy.

Page 26. Add. CHRISTIE, N. R. The Pinon Jay. *Osprey, III.* 1898, *p. 57.*

Short account of its breeding habits near Rouse Junction, Colorado.

Page 27. Add. COOKE, W. W. The State Agricultural College, The Agricultural Experiment Station, Bulletin No. 44, Technical Series No. 4, Further Notes on the Birds of Colorado, An Appendix to Bulletin No. 37, on the Birds of Colorado. By W. W. Cooke. Approved by the Station Council. Alston Ellis, President. Fort Collins, Colorado, March,

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1898. The Smith-Brooks Printing Company, Denver, *pp. 145-176.* [Date of distribution, March, 1898.]

Adds eleven new species to the state list; references to 15 books and articles; additional notes on 98 species.

COOKE, W. W. The Scarlet Ibis—A Correction. *Auk, XV.* 1898, *p. 183.*

Statement that the specimens of Scarlet Ibis reported in the *Auk, XIV.* 1897, *p. 316,* proved to be the White-faced Glossy Ibis.

COOKE, W. W. A New Bird for Colorado. *Osprey, III.* 1898, *p. 13.*

A Le Conte's Sparrow taken by E. Carter at Breckenridge, October 2, 1896. It is stated that this is the first mountain record, but this is an error, as Merrill, *Auk, XV,* 1898, *p. 16,* had just previously recorded it from Idaho, west of the mountains, but at a much lower altitude. Breckenridge is 9,500 feet altitude. The article also contains records at Breckenridge of the Slate-colored Sparrow, Mockingbird and Bobolink.

COOKE, W. W. More New Birds for Colorado. *Auk, XVI.* 1899, *p. 187.*

Adds three new species to the state list, *Branta canadensis minima, Astragalinus psaltria mexicanus* and *Junco montanus.*

Page 29. Add. DILLE, F. M. Nesting of the Pine Siskin at Denver, Colo. *The Condor, II.* 1900, *p. 73.*

Several nests in the spring of 1899 within the city limits of Denver.

Page 31. Add. FREMONT, JOHN C. Report of the Exploring Expedition to the Rocky Mountains in the year 1842, and to Oregon and north California in the years 1843-4. By Brev. Capt. J. C. Fremont of the topographical engineers, under the orders of Col. J. J. Abert, chief of the topographical bureau. Printed by order of the House of Representatives, Washington; Blair & Rives, printers. 1845, *p. 586.*

Capt. Fremont crossed the State by way of the Grand river and the South Platte. His narrative contains only a few unimportant references to Colorado birds.

Page 31. Add. GILMORE, L. D. Western Goshawk in Colorado. *Osprey, III.* 1898, *p. 28.*

One shot at Sweetwater Lake, Garfield county, Colorado, February 12, 1898, by J. T. Meirer, and identified by the Smithsonian as *striatulus.* Two others seen later.

GILMORE, L. B. Some Notes on Colorado Birds. *Bul. Mich. Orn. Club. II.* April, 1898, *p. 19.*

Notes on seventeen species of birds seen in the vicinity of Dotsero, Colorado.

GILMORE, L. B. Notes on the Western Yellow-throat and Amer-

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ican Raven in Colorado. *Bul. Mich. Orn. Club, III.* January, 1899, *p. 8.*

Notes on these two species seen near Dotsero.

Page 32. Add. HOWE, R. H., JR. Ranges of *Hylocichla fuscescens*, and *Hylocichla fuscescens salicicola* in North America. *Auk, XVII.* 1900, *p. 22.*

Measurements of two specimens of *salicicola* taken in Colorado.

Page 32. Add. INGERSOLL, EARNEST. Knocking Round the Rockies. Harper Bros., N. Y., 1883.

Contains descriptive notes on several Colorado birds.

Page 33. Add. "J." [CAPT. P. M. THORNE.] Snipe Wintering in Colorado. *Forest and Stream.* February 15, 1882.

Two Wilson's Snipe (*Gallinago delicata*) found February 3, 1882, at Fort Lyon, Colorado. The gizzard of the one shot contained partly digested fish.

Page 33. Add. JOHNSON, H. C. In the Breeding Home of Clarke's Nutcracker (*Nucifraga columbianus*). *The Condor, II.* 1900, *p. 49.*

Mentions all the nests of this bird taken in Colorado previous to 1900.

JONES, LYNDS. The Songs of the Warblers. (*Mniotiltidæ*). Laboratory Bulletin No. 10. Oberlin College. Also issued as Wilson Bulletin No. 30. Oberlin, Ohio, March 20, 1900, *p. 57.*

Notes on all the Warblers known to occur in the United States, with specific references to several of them as occurring in Colorado.

JONES, P. L. Flammulated Owls. *Osprey, III.* 1898, *p. 46.*

Records of three more captures near Beulah, Colorado, and one set of eggs.

Page 33. Add. KEYSER, LEANDER S. Rocky Mountain Birds. *Popular Science, XXXIV.* 1900, *p. 3.*

Short account of several common birds seen near Manitou.

KEYSER, LEANDER S. Rocky Mountain Birds. N. Y. Evening Post (newspaper), September 2, 1899.

Observations on the birds near Colorado Springs and Manitou.

Page 35. Add. NASH, H. W. Our Winter Birds. *The Cactus.* (Local magazine, Pueblo, Colorado.) *II, No. 1,* 1892.

Notes on the winter birds of Pueblo.

Page 35. Add. NELSON, E. W. Description of a new Subspecies of *Meleagris gallopavo* and proposed changes in the nomen-

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clature of certain North American Birds. *Auk, XVII.* 1900, *p. 120.*

Describes a new sub-species, ***Meleagris gallopavo merriami***, and assigns to it the wild turkeys of southwestern Colorado.

Page 35. Add. OBERHOLSER, HARRY C. Description of a new North American Thrush. *Auk, XV.* 1898, *p. 303.*

Describes *H. u. almæ*, subsp. nov. and gives Colorado as included in its habitat. This subspecies has been rejected by the A. O. U.

OBERHOLZER, HARRY C. A Revision of the Wrens of the Genus *Thryomanes* Sclater. *Proc. U. S. Nat. Mus., XXI. No. 1153,* 1898, *p. 427.*

Gives a new name, ***Thryomanes bewickii eremophilus***, to the form that occurs in Colorado. Up to January, 1900, this had not been passed upon by the A. O. U.

Page 36. RIDGWAY, ROBERT. New Species, etc., of American Birds, II. Fringillidæ (continued). *Auk, XV.* 1898, *p. 319.*

Describes a new subspecies, ***Calcarius lapponicus alascensis***, Alaskan Longspur, and includes Colorado in its habitat.

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THE HISTORY OF COLORADO ORNITHOLOGY.

Page 41. Add.

1864 6. **Baird.** *Review of American Birds.* Adds *Lanius ludovicianus excubitorides* taken in Colorado by D. Thompson.

Page 42.

Under 1872. **Allen.** Omit *Lanius ludovicianus excubitorides*, as it had already been recorded by Baird in his Review of American Birds.

Page 48. Add.

1898. **Cooke.** *Osprey, III.* 1898, *p. 13. Ammodramus leconteii* taken by Carter at Breckenridge.

1899. **Cooke.** *Auk, XVI.* 1899, *p. 187. Astragalinus psaltria mexicanus* and *Branta canadensis minima* taken at Denver; *Junco montanus* taken at Pueblo.

1900. **Cooke.** *Colorado Experiment Station Bulletin No. 56.* The present publication contains the first records for Colorado of nine species as follows: *Gavia arctica, Ardetta egretta, Syrnium nebulosum, Astragalinus tristis pallidus, Geothlypis agilis, Geothlypis trichas* and *Wilsonia canadensis* by Aiken; *Plegadis autumnalis* by A. T. Allen; *Falco sparverius deserticolus* by Carter.

Page 48. **RECAPITULATION.** Add.

1898..	W. W. Cooke.....	1	364
1898..	W. W. Cooke.....	10	374
1898..	W. W. Cooke.....	1	375
1899..	W. W. Cooke.....	3	378
1900..	W. W. Cooke.....	9	387

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THE BIRDS OF COLORADO.

Page 49. 1. **Æchmophorus occidentalis.** WESTERN GREBE.

Two shot out of three seen on Sheldon's Lake, near Fort Collins, October 29, 1898, by Wils Black. One of them is now mounted in the museum of the Agricultural College.

This species has been seen by Edwin Carter in South Park, but not taken.

Page 49. 4. **Colymbus nigricollis californicus.** AMERICAN EARED GREBE.

Has been seen at Breckenridge in migration by Edwin Carter, and breeds abundantly in Middle Park. In the following pages many records of Mr. Carter are given which are not in a certain sense new records, since they would be implied by the knowledge of the occurrence of the species in neighboring localities, but they are entered here both as a record of Mr. Carter's wide study of Colorado birds in localities not visited by other naturalists, and to furnish additional proof of the correctness of previous published records. Breckenridge is on the Blue River at an elevation of 9,500 feet, and about fifty miles from the junction of the Blue and the Grand rivers. Most of Mr. Carter's records of "Middle Park" meant the country around the mouth of the Blue river, with an altitude of 7,000–7,500 feet. His expeditions cover considerable of South Park, but most of his collecting has been along the branches of the South Platte on the eastern side of the park at about 8,000 feet.

Page 50. 6. **Podilymbus podiceps.** PIED-BILLED GREBE.

Seen by Mr. Carter at Breckenridge in migration, but never known to breed there.

Page 50. 7. Change to **Gavia imber.** LOON.

This and many changes given later are made to conform with the present nomenclature of the American Ornithologists'

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Union. In the remainder of these notes the words "Change to" will be omitted and merely the present name given.

Seen by Mr. Carter in Middle Park. Mr. L. B. Gilmore reports that one was shot in July, 1897, on Sweetwater Lake, was mounted and is now in the possession of Mr. John Root. This is the first summer record for Colorado.

Page 50. Add. 9. **Gavia arctica.** BLACK-THROATED LOON.

A northern species occurring as a rare fall and winter visitant to Colorado.

Mr. C. E. Aiken of Colorado Springs, contributes the following notes.

"Three small Loons were observed on Prospect Lake in the suburbs of Colorado Springs, in November, 1898, and all were shot by a local gunner. One which I subsequently examined proved to be of this species.

"I also examined in 1883 a specimen killed, I think, the previous fall near Colorado Springs.

"Colorado is within the probable winter range of the species, and it may be a regular visitant."

Page 50. Add. [10. **Gavia pacifica.** PACIFIC LOON.

One was shot in November, 1899, near Clayton, New Mexico, just over the Colorado line, and was presented by Mr. Jesse Harris to the museum of the Agricultural College at Fort Collins.

This is the western form, not before recorded east of the Rocky Mountains.]

Page 50. Add. [11. **Gavia lumme.** RED-THROATED LOON.

The distribution of this species is given in the A. O. U. Check List as "Northern part of northern hemisphere, migrating southward in winter nearly across the United States." This would bring Colorado within the limits of its distribution, and hence it is one of the species that should be especially sought. It has been taken in Nebraska.

In the following pages about twenty such species are included as showing what will probably be found some day in Colorado, and to direct attention to them as species for future investigation.]

Page 50. 53. **Larus californicus.** CALIFORNIA GULL.

Mr. Carter's collection contains two specimens of this Gull; one taken April 28, 1884, in Middle Park at 7,000 feet, and the other taken at Denver, October 26, 1878.

Page 51. 54. **Larus delawarensis.** RING-BILLED GULL.

The present writer found this species breeding quite commonly June 18, 1898, at the San Luis Lakes at an altitude of 7,500, being more than a thousand feet above previous breeding records. Mr. Carter has never found them breeding nor seen them in fall migration, but in spring has seen them in both South and Middle Parks.

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Page 51. 60. **Larus philadelphia.** BONAPARTE'S GULL.

Three more instances are known from Colorado Springs, Denver and Longmont. The one from Denver is in winter plumage. Mr. Carter has taken one in Middle Park in the spring, this being the first record for Colorado west of the range.

Page 51. 62. **Xema sabinii.** SABINE'S GULL.

Mr. Carter has a specimen taken September 26, 1886, on an alpine lake near Breckenridge at over 10,000 feet. Mr. Aiken killed one at Manitou Park, October 10, 1897.

Page 51. Add. [64. **Sterna tschegrava.** CASPIAN TERN.

"Nearly cosmopolitan; in North America breeding southward to Virginia, Lake Michigan, Texas, Nevada and California."—(A. O. U.) Has been taken in Nebraska and probably will later be added to Colorado birds.]

Page 51. 69. **Sterna forsteri.** FORSTER'S TERN.

Noted by Mr. Carter only in migration.

Page 51. Add. [70. **Sterna hirundo.** COMMON TERN.

This Tern occurs over all of North America, but chiefly east of the plains. Specimens of both young-of-the-year and old birds are in Mr. Bond's collection, taken at Cheyenne. It is also known from Kansas and Nebraska, so we may confidently expect that the future will add this to the list of Colorado birds.]

Page 52. [74. **Sterna antillarum.** LEAST TERN.

"Northern South America, northward to California, Minnesota and New England, and casually to Labrador, breeding nearly throughout its range."—(A. O. U.) Has been noted many times in both Nebraska and Kansas and undoubtedly comes into eastern Colorado, though up to the present it has no Colorado record.]

Page 52. Add. [121. **Phalacrocorax mexicanus.** MEXICAN CORMORANT.

"West Indies and Central America to southern United States; north in the interior to Kansas and southern Illinois."—(A. O. U.) There has also been a specimen reported from Nebraska, so it should be looked for in Colorado.]

Page 52. 125. **Pelecanus erythrorhynchos.** AMERICAN WHITE PELICAN.

Several late records indicate that these birds have not yet deserted Colorado. A flock of about forty was seen feeding on a small lake near Denver in the spring of 1898.

Mr. Carter has one taken at Breckenridge, August 10, 1892, has seen them in both Middle and South Parks, has seen them feeding on alpine lakes and even migrating over the mountain passes at 13,000 feet.

Page 52. Add. [126. **Pelecanus fuscus.** BROWN PELICAN.

One was taken July 12, 1899, near Cheyenne, Wyoming, and is now in the Bond collection.

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Page 52. 129. **Merganser americanus.** AMERICAN MERGANSER.

Breeds at Breckenridge.

Page 53. 130. **Merganser serrator.** RED-BREASTED MERGANSER.

One taken by Mr. Carter in Middle Park is the first record west of the range in Colorado.

Page 53. 131. **Lophodytes cucullatus.** HOODED MERGANSER.

Mr. Carter has one taken June 1, 1871, near Canon City.

Page 53. 132. **Anas boschas.** MALLARD.

Taken breeding by Mr. Carter in South and Middle Parks.

Page 53. In place of 133. **Anas obscura.** BLACK DUCK. Put

134a. **Anas fulvigula maculosa.** MOTTLED DUCK.

Although no specimens of this duck taken in Colorado have been examined by the present writer, yet there can be no doubt that the three specimens reported really belong to this subspecies.

Page 53. 135. **Chaulelasmus streperus.** GADWALL.

Breeds in Middle Park, according to Mr. Carter.

Page 54. 137. **Mareca americana.** BALDPATE.

Seen by Mr. Carter in summer in Middle Park at 7,000.

Page 54. 139. **Nettion carolinensis.** GREEN-WINGED TEAL.

140. **Querquedula discors.** BLUE-WINGED TEAL.

141. **Querquedula cyanoptera.** CINNAMON TEAL.

142. **Spatula clypeata.** SHOVELLER.

These four species of ducks have all been found by Mr. Carter at Breckenridge in migration, but are none of them known by him to breed at that altitude, though all breed in the great mountain parks.

Page 55. 143. **Dafila acuta.** PINTAIL.

Mr. Carter has taken Pintails in Middle Park at a little over 7,000 feet.

Page 55. 144. **Aix sponsa.** WOOD DUCK.

Two occurrences near Cheyenne are reported by Mr. Bond, who says they are quite common in northern Wyoming. Mr. A. T. Allen has known several instances in the vicinity of Denver, but none of these were in the summer.

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Page 55. 146. **Aythya americana.** REDHEAD.

Facts are accumulating which make it probable that this species will in the near future be accounted among the breeding birds of Colorado. Several of these birds stayed in the reservoir at City Park in Denver all the summers of 1898 and 1899, but there was nothing to indicate that they nested there. A red-headed duck, presumably of this species, a fine male, was shot at the San Luis Lakes, June 18, 1898. This species, as well as the Canvas-back, is known to breed from northern United States northward.

Page 55. 147. **Aythya vallisneria.** CANVAS-BACK.

Page 55. 148. **Aythya marila.** SCAUP DUCK.

Page 56. 149. **Aythya affinis.** LESSER SCAUP DUCK.

These three have been taken by Mr. Carter at Breckenridge in migration.

Page 56. 152. **Clangula islandica.** BARROW'S GOLDEN-EYE.

Mr. Carter reports these ducks as common breeders in Middle Park, and that he once found them nesting at Georgia Pass at an altitude of 10,000 feet. As recorded by Brewer, *B. N. O. C. IV.*, 1879, *p. 148*, Mr. Carter took in Colorado in 1876 the first eggs of this species known to science.

Paae 56. 153. **Charitonetta albeola.** BUFFLE-HEAD.

In the Carter collection is a fine male taken in Middle Park April 14, 1877, and a female taken May 5, 1884. Mr. Carter says that later in 1884, sometime in July, in Middle Park, he took both male and female. The male was in such worn plumage that it was not saved. The female was kept and mounted, but is not now on hand. Known to breed from northern United States northward.

Page 56. 154. **Harelda hyemalis.** OLD-SQUAW.

On October 16, 1898, B. Haywood killed two at Calkins' Lake near Longmont. On October 23 he killed another at the same place. Skins of two of these are now at the capitol at Denver.

Page 57. 155. **Histrionicus histrionicus.** HARLEQUIN DUCK.

Mr. Carter has found it breeding in Middle Park and on the Blue river a little below Breckenridge at 9,200 feet altitude.

Page 57. 165. **Oidemia deglandi.** WHITE-WINGED SCOTER.

One was shot on Barr Lake near Denver, November 2, 1898, and reported by Mr. Fenton.

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Page 57. 166. **Oidemia perspicillata.** SURF SCOTER.

Two were killed at Loveland on October 31, 1899, by Mr. H. A. Flynn of Denver.

A few days before, on October 22, Mr. L. B. Meek shot a fine male at Barr Lake near Denver. The female was with it, but was not secured. Three other specimens were known at the same place within the next week.

Page 57. 167. **Erismatura jamaicensis.** RUDDY DUCK.

At Breckenridge, Mr. Carter knows them only as migrants, though they nest but a little lower down toward the Park.

Page 58. 169. **Chen hyperborea.** LESSER SNOW GOOSE.

Once seen by Mr. Carter in Middle Park.

Page 58. 169a. **Chen hyperborea nivalis.** GREATER SNOW GOOSE.

One was killed by Mr. John F. Campion of Denver, at Boyd's Lake near Loveland, April 9, 1899. It was a female and is now in the capitol at Denver.

Page 58. Add. [169. 1. **Chen caerulescens.** BLUE GOOSE.

"Interior of North America, breeding on eastern shores of Hudson Bay and migrating south, in winter, through Mississippi valley to Gulf coast."—(A. O. U.) "Interior of North America east of the Rocky Mountains."—(Goss.) Noted from Kansas and Nebraska as not uncommon in fall and winter.]

Page 58. 171a. **Anser albifrons gambeli.** AMERICAN WHITE-FRONTED GOOSE.

There is one in the Carter collection taken in Middle Park, and Mr. Carter says that in migration he has sometimes seen them there in quite large numbers.

Page 58. 172. **Branta canadensis.** CANADA GOOSE.

In migration at Breckenridge and breeds in Middle Park.

Page 59. Add. 172c. **Branta canadensis minima.** CACKLING GOOSE.

There is one at the capitol in Denver, killed by Mr. John F. Campion at Loveland, April 10, 1898, and presented by him to the State Natural History Society.

Page 59. 180. **Olor columbianus.** WHISTLING SWAN.

One taken by Mr. Carter in Middle Park.

Page 60. Add. 186. **Plegadis autumnalis.** GLOSSY IBIS.

Accidental. A fine specimen of this bird in full plumage is

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at Mr. A. T. Allen's in Denver. It was shot by him near Denver several years ago. This is the southern form and Denver is many miles north of its ordinary range. Mr. Aiken writes that Mr. B. G. Voight of Denver shot an adult male April 12, 1898, along the Arkansas river, three miles west of Salida. Mr. Voight has the mounted specimen still in his possession.

Page 60. 187. **Plegadis guarauna.** WHITE-FACED GLOSSY IBIS.

Several more records have been received. Two specimens were shot on Barr Lake near Denver, October 3, 1898. Four were shot in the fall at Twin Lakes at an elevation of 9,000 feet. Mr. A. T. Allen has a young-of-the-year taken near Denver. Mr. Carter has taken them in South and Middle Parks and at Twin Lakes, and there is a specimen at Glenwood Springs shot in the vicinity. These last two are the first records west of the range in Colorado.

Page 60. 188. **Tantalus loculator.** WOOD IBIS.

Mr. Carter has seen the wing and bill of one taken on the Blue river, twenty-five miles below Breckenridge, at about 8,000 feet.

Page 60. 190. **Botaurus lentiginosus.** AMERICAN BITTERN.

Found by Mr. Carter breeding in both Middle and South Parks.

Noted by Mr. A. D. Baker in the Wet Mountain valley at 8,000 feet.

Page 61. 191. **Ardetta exilis.** LEAST BITTERN.

A mounted specimen is now in Denver, taken by Mr. Rudolph Borcherdt on Berkeley Lake near Denver, June 8. 1898. Mr. Carter has one taken in South Park, May 14, 1875, and Mr. A. D. Baker has seen one in the Wet Mountain valley at over 8,000 feet.

Page 61. 194. **Ardea herodias.** GREAT BLUE HERON.

Once found by Mr. Carter, breeding in Middle Park at 7,000 feet altitude, and it has been seen by Mr. A. D. Baker in the Wet Mountain valley at least a thousand feet higher.

Page 61. Add. 196. **Ardea egretta.** AMERICAN EGRET.

Rare or accidental in spring. Mr. C. E. Aiken writes as follows: "On May 12th, 1899, Mr. A. Gruber and Mr. F. Cikanck—taxidermists in my employ—reported seeing a single bird in a tall cottonwood tree five miles south of Colorado

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Springs. As they are familiar with this species, as well as the more common *A. candidissima*, there appears no reason to doubt their identification.

Page 61. 197. **Ardea candidissima.** SNOWY HERON.

So many records for Colorado are accumulating of this species that it must be counted as a regular summer visitant to the state, whether or not it breeds. Two more specimens are known from Denver; three known by Mr. Aiken at Colorado Springs the spring of 1899; one at Glenwood Springs the spring of 1898, while Mr. Carter has not only taken them in Middle and South Parks, but even at Twin Lakes at 9,000 feet. A male and female were taken together by Mr. Carter, May 12, 1896, on the Gunnison river.

Page 61. Add. [201. **Ardea virescens.** GREEN HERON.

"Temperate North America."—(A. O. U.) Common summer resident of Nebraska and Kansas. Also known as common in the states west of Colorado. Should be noted before long from Colorado.

Page 61. 202. **Nycticorax nycticorax nævius.** BLACK-CROWNED NIGHT HERON.

In 1875 Mr. Aiken found them breeding at the San Luis Lakes and secured eggs. The present writer also found them there in 1898. Mr. Carter has taken them in both Middle and South Parks. Mr. L. B. Gilmore saw them on Sweetwater Lake at 8,000 feet, which is one of the highest records for this species.

Page 62. 205. **Grus canadensis.** LITTLE BROWN CRANE.

Mr. A. T. Allen has a mounted specimen, shot several years ago near Denver.

Page 62. 206. **Grus mexicana.** SANDHILL CRANE.

Mr. Carter has known of their breeding in Middle Park to about 8,000 feet, and Mr. Baker saw some November 15, 1899, in the Wet Mountain valley at about the same altitude.

Page 63. Add. [208. **Rallus elegans.** KING RAIL.

In Goss' "Birds of Kansas" this species is given as extending "West into Colorado." There seems to be an error about this, and there is at present no undoubted record of this bird in Colorado. Since, however, it is a common species in Kansas and Nebraska, nearly to the Colorado line, we may expect sooner or later to have the above record verified.]

Page 63. 212. **Rallus virginianus.** VIRGINIA RAIL.

Taken by Mr. Aiken at the San Luis Lakes, June 30, 1875, and therefore breeding there at 7,500 feet. One was brought to Mr. Aiken that was shot February 16, 1899, at a spring five miles from Colorado Springs. It was a male in good condition,

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though this was the middle of one of the severest winters ever known in Colorado, with the temperature many degrees below zero. Several were said to have been seen, and also a smaller, darker kind that was probably *carolina*. Has been seen by Mr. Baker in the Wet Mountain valley at over 8,000 feet.

Page 63. 214. **Porzana carolina.** SORA.

Taken by Mr. Carter at Breckenridge, and breeds from Middle Park up the Blue river to about 9,000 feet.

Page 63. Add. [215. **Porzana noveboracensis.** YELLOW RAIL.

"Chiefly eastern North America, north to Nova Scotia, Hudson Bay, etc., less commonly west to Nevada and California."—(A. O. U.) Thus by implication Colorado is included in its habitat, but it has not yet been found here. Known as not uncommon in Kansas and Nebraska.]

Page 63. 221. **Fulica americana.** AMERICAN COOT.

Breeds in Middle and South Parks, but known by Mr. Carter at Breckenridge only in migration.

Page 63. 223. **Phalaropus lobatus.** NORTHERN PHALAROPE.

Mr. Carter saw several in Middle Park at 7,000 feet, May 26, 1884. He has taken them at Breckenridge in migration.

Page 63. 224. **Steganopus tricolor.** WILSON'S PHALAROPE.

Two pairs were taken near Glenwood Springs during the spring of 1898. Mr. Carter has taken them in migration in both Middle and South Parks, but not at Breckenridge. On September 1, 1885, he took a young-of-the-year at timber line.

Page 64. 225. **Recurvirostra americana.** AMERICAN AVOCET.

At the same places where Aiken found them breeding in the San Luis valley in 1875, the present writer found them breeding in 1898. Mr. Carter says that he has found them breeding in South Park, and has taken them in migration at Breckenridge.

Page 64. 230. **Gallinago delicata.** WILSON'S SNIPE.

Mr. L. B. Gilmore reports it as remaining nearly every winter around Sweetwater Lake at 8,000 feet. About January 20, 1900, he saw nine at one time. It also breeds sparingly in that vicinity. At Breckenridge it has been noted only in migration.

Page 65. 233. **Micropalama himantopus.** STILT SANDPIPER.

Several more records have come to hand of this rare Sandpiper. Mr. Aiken took one at Colorado Springs, May 14, 1884.

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Mr. Carter has one taken at Breckenridge, and has also taken them years ago in both Middle and South Parks.

Page 65. Add. [234. **Tringa canutus.** KNOT.
"Nearly cosmopolitan. Breeds in high northern latitudes, but visits the southern hemisphere during its migrations."—(A. O. U.) Should be looked for in Colorado, as it has been taken in both Kansas and Nebraska.]

Page 65. 241. **Tringa bairdii.** BAIRD'S SANDPIPER.

242. **Tringa minutilla.** LEAST SANDPIPER.

246. **Ereunetes pusillus.** SEMIPALMATED SANDPIPER.

All three have been taken by Mr. Carter in Middle and South Parks,

Page 66. 249. **Limosa fedoa.** MARBLED GODWIT.

Mr. Carter has taken them as high as Breckenridge, far above their ordinary range.

Page 66. 254. **Totanus melanoleucus.** GREATER YELLOW-LEGS.

Taken by Mr. Carter in migration in both Middle and South Parks, and by Mr. Baker in Wet Mountain valley, at least to 8,000 feet.

Page 66. 255. **Totanus flavipes.** YELLOW-LEGS.

Taken by Mr. Carter in migration in both Middle and South Parks.

Page 67. 256. **Helodromas solitarius.** SOLITARY SANDPIPER.

Page 67. 258a. **Symphemia semipalmata inornata.** WESTERN WILLET.

At Breckenridge Mr. Carter has noted it only in migration.

Page 67. Add. [262. **Tryngites subruficollis.** BUFF-BREASTED SANDPIPER.
"North America, especially in the interior."—(A. O. U.) Known from Kansas and Nebraska and should be taken in Colorado.

Page 67. 263. **Actitis macularia.** SPOTTED SANDPIPER.

Breeds at Breckenridge.

Page 67. 264. **Numenius longirostris.** LONG-BILLED CURLEW.

Taken by Mr. Carter at Breckenridge in migration, and found by him breeding in Middle and South Parks.

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Page 68. 270. **Squatarola squatarola.** BLACK-BELLIED PLOVER.

In Mr. Bond's collection is a very fine specimen in *full breeding plumage*, taken at Cheyenne, May 21, 1898.

Page 68. 273. **Ægialitis vocifera.** KILLDEER.

Breeds at Breckenridge.

Page 68. 274. **Ægialitis semipalmata.** SEMIPALMATED PLOVER.

One in Mr. Carter's collection was shot from a large flock seen by him in the fall on Grand Lake in Middle Park.

Page 68. Add. [277a. **Ægialitis meloda circumcincta.** BELTED PIPING PLOVER.

There is one in the Bond collection, taken at Cheyenne, May 13, 1892, but although this is so close to Colorado, and it is known in both Kansas and Nebraska, yet up to the present time it has no record for this State.]

Page 68. Add. [278. **Ægialitis nivosa.** SNOWY PLOVER.

"Western United States, from California east to Kansas and western Gulf States."—(A. O. U.) Surely this ought to include Colorado, but it has no record here as yet.]

Page 68. 281. **Ægialitis montana.** MOUNTAIN PLOVER.

Mr. Carter has never seen them at Breckenridge, even in migration, but has found them breeding in South Park.

Page 69. 283. **Arenaria interpres.** TURNSTONE.

Eight of these birds were killed on Berkeley Lake near Denver, May 18, 1900, and four of them, two males and two females, were mounted by Mr. Rudolph Borcherdt.

Page 69. 289. **Colinus virginianus.** BOB-WHITE.

Introduced about 1891 near Grand Junction and still occurs there, but not in anywhere near the numbers of the California Partridge. They occur in the Wet Mountain valley to at least 8,000 feet. They are native and not uncommon at Wray, in eastern Colorado on the plains.

Page 69. Add. [289b. **Colinus virginianus texanus.** TEXAN BOB-WHITE.

As its name implies, this is a Texas species, inhabitating southern and western Texas. It has been taken in southwestern Kansas. If it occurs anywhere in Colorado it would be in the extreme southeastern corner, along the Cimarron river. No ornithologist has ever penetrated this part of Colorado, which undoubtedly holds many new records for the fortunate one that explores it. It is fair to presume that of the dozen or fifteen species known to occur along the Cimarron a little further east, that have not yet been taken in Colorado, that several follow it up occasionally into this State. Whoever goes into that country should seek especially for the Lesser Prairie Hen, the Texan Bob-white, and settle definitely whether the Turkey of that region is the eastern form. So far as is known to the present writer, all of the Turkeys in the various collections in the State are referable to the Mexican form.

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Page 69. 293. **Callipepla squamata.** SCALED PARTRIDGE.

A queer state of affairs has come to light in regard to the occurrence of this species in Colorado, that shows strongly how much there is yet to be learned about Colorado ornithology. In 1895 W. P. Lowe gave in the Auk the first published record of this species for Colorado. It was considered a rare specimen and extended the known range nearly three hundred miles northeastward. Two years ago a specimen was sent to the present writer that was taken at Rocky Ford, but was supposed to have been introduced there. Now it has become known that they are common among the cedars on the higher arid lands back from the river and miles away from water. The cowboys that rode the range at least sixteen years ago, report that they were more plentiful there then than they are now. Lately they have been working toward the cultivated lands along the river, and during the winter of 1899-1900 they have become, in the vicinity of Rocky Ford, more common than the Bob-white. The Scaled Partridge should therefore be considered as resident; common locally.

Page 69. 294. **Lophortyx californicus.** CALIFORNIA PARTRIDGE.

A few years ago nearly a thousand of these birds were turned loose at Grand Junction. They have thriven wonderfully and the country now is full of them. They average two broods per year and the market gardeners claim they are a nuisance in their vegetable gardens.

Page 70. 295. **Lophortyx gambelii.** GAMBEL'S PARTRIDGE.

Page 70. 297. **Dendragapus obscurus.** DUSKY GROUSE.

Breeds at Breckenridge.

Page 70. 300b. **Bonasa umbellus umbelloides.** GRAY RUFFED GROUSE.

At last the present writer has had the good fortune to see this bird with his own eyes. A family of old and young were seen August 12, 1899, on South Fork in Estes Park, at 9,000 feet elevation.

Page 70. 304. **Lagopus leucurus.** WHITE-TAILED PTARMIGAN.

Breeds at Breckenridge.

Page 71. 305. **Tympanuchus americanus.** PRAIRIE HEN.

Resident. Further records of this species allow us now to include it among the breeders. Mr. Otto Derr writes that at

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Wray the Prairie Hen is not an uncommon breeder, occurring there with the Sharp-tailed Grouse and Bob-white.

Page 71. 308b. **Pediœcetes phasianellus campestris.** PRAIRIE SHARP-TAILED GROUSE.

Mr. Carter says that they breed in Middle Park, but only in the lower parts, not above 7,500 feet. In winter they have been noted up to 9,500 feet.

Page 71. 309. **Centrocercus urophasianus.** SAGE GROUSE.

The highest that Mr. Carter has found them breeding is at Dillon, about 9,000 feet. In their migration, or more properly, wanderings, he has taken them at Breckenridge, and has even seen them crossing the main range at 14,000 feet.

Page 71. 310a. **Meleagris gallopavo fera.** WILD TURKEY.

As late as 1898 Turkeys were seen in Wet Mountain valley, and though they are entered here as belonging to the eastern form this is without sure proof, and the line in Colorado separating the two forms has not yet been settled.

Page 72. 310. **Meleagris gallopavo.** MEXICAN TURKEY.

The Turkey in Mr. Carter's collection is a well marked specimen of the western bird, though taken on the Atlantic slope in South Park in January, 1878.

Page 72. 312. **Columba fasciata.** BAND-TAILED PIGEON.

Mr. Carter has found them nesting in South Park, but has never seen them at Breckenridge. The present writer saw a flock of eight at Mary's Lake in Estes Park in August, 1898, and a single bird at the same place the next August.

Page 73. Add. [315. **Ectopistes migratorius.** PASSENGER PIGEON.

"Eastern North America, from Hudson Bay southward, and west to the Great Plains, straggling thence to Nevada and Washington."—(A. O. U.) It would be strange if the true eastern Pigeon did not occur occasionally in Colorado, and it has several times been reported here. All of these records or statements, when followed up, prove to be the Band-tailed Pigeon.]

Page 73. 316. **Zenaidura macroura.** MOURNING DOVE.

Breeds at Breckenridge.

Page 73. 319. **Melopelia leucoptera.** WHITE-WINGED DOVE.

One was shot by Mr. A. D. Baker in the Wet Mountain valley in September, 1899. This is the fourth record for Colorado, and makes it probable that the bird is not a mere straggler to the State.

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Page 73. Add. [326. **Catharista urubu.** BLACK VULTURE.
"South Atlantic and Gulf States, * * * west to the Great Plains, * * * straggling north to South Dakota."—(A. O. U.) Has been taken in western Kansas and probably will some time be found as a rare summer visitant in southeastern Colorado.]

Page 73. 331. **Circus hudsonius.** MARSH HAWK.
Breeds to at least 8,000 feet, near Breckenridge.

Page 74. 332. **Accipiter velox.** SHARP-SHINNED HAWK.
Breeds at Breckenridge.

Page 74. 333. **Accipiter cooperi.** COOPER'S HAWK.
Not known by Mr. Carter to breed at Breckenridge, though not uncommon as a breeder a little lower in Middle Park.

Page 74. 334. **Accipiter atricapillus.** AMERICAN GOSHAWK.
Occurs at Breckenridge both in summer and in winter.

Page 74. 334a. **Accipiter atricapillus striatulus.** WESTERN GOSHAWK.
One was shot at Sweetwater Lake, Garfield county, February 12, 1898, by Mr. J. T. Meirer, and identified by the Smithsonian. Two others were seen later. One was taken near Colorado Springs in winter, and is now in Mr. Aiken's collection. Mr. Carter has quite a collection of Goshawks taken in the vicinity of Breckenridge, largely intermediates, but nearly half of them would be classed under the head of *striatulus*.

Page 75. 337b. **Buteo borealis calurus.** WESTERN RED-TAIL.

Page 75. 342. **Buteo swainsoni.** SWAINSON'S HAWK.

Page 75. 348. **Archibuteo ferrugineous.** FERRUGINOUS ROUGH-LEG.

Page 75. 349. **Aquila chrysaetos.** GOLDEN EAGLE.
These four are represented in the Carter collection and all breed at Breckenridge.

Page 76. 352. **Haliæetus leucocephalus.** BALD EAGLE.
Mr. Carter has known of its breeding at Breckenridge and nearly to 10,000 feet.

Page 76. 360. **Falco sparverius.** AMERICAN SPARROW HAWK.
A Sparrow Hawk in the collection of the Agricultural College at Fort Collins, taken on the plains near there, is referable to the eastern form, but shows a tendency toward the western. Of five adult birds in Mr. Carter's collection, taken in the moun-

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tains, two are eastern and three western. One of the eastern birds was taken east of the range and the other west.

Page 76. Add. 360a. **Falco sparverius deserticolus.** DESERT SPARROW HAWK.

Resident. Two adult males and one adult female in Mr. Carter's collection are clearly referable to the western form. They were taken in Middle and South Parks.

Page 77. 364. **Pandion haliaetus carolinensis.** AMERICAN OSPREY.

Mr. Carter has seen them at Breckenridge, and knows of their nesting as high as 8,500 feet, on the Blue river.

Page 77. 365. **Strix pratincola.** AMERICAN BARN OWL.

One has been seen by Mr. A. D. Baker in the Wet Mountain valley. An adult female was shot at Rocky Ford in June, 1898, and is now in the collection of A. J. Dean.

Page 77. 366. **Asio wilsonianus.** AMERICAN LONG-EARED OWL.

Common near Breckenridge.

Page 77. 367. **Asio accipitrinus.** SHORT-EARED OWL.

Has been taken at Breckenridge in winter.

Page 77. Add. 368. **Syrnium nebulosum.** BARRED OWL.

Resident. A common species of eastern United States, west to Nebraska and Kansas, now first added to Colorado birds by the following note from Mr. C. E. Aiken:

"In March, 1897, Mr. B. G. Voight found a pair of these Owls breeding near Holyoke, in the northeast corner of the state. Two eggs, somewhat incubated, and one of the birds were secured."

Page 77. 371. **Nyctala tengmalmi richardsoni.** RICHARDSON'S OWL.

A second specimen for Colorado is the one taken by Mr. Carter at Breckenridge, December 28, 1882, and now in his collection.

Page 77. 372. **Nyctala acadica.** SAW-WHET OWL.

Mr. Carter's collection contains an adult taken at Breckenridge and also a young-of-the-year taken there August 10, 1884. Though Mr. Carter has seen no nests at Breckenridge, there can be little doubt that they breed there.

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As the present writer was working on this part of this bulletin, January 31, 1900, one of our students caught a fine specimen in his hands in one of the evergreens near the main College building.

Page 78. 374. **Megascops flammeola.** FLAMMULATED SCREECH OWL.

Nine new records for Colorado and four instances of breeding can be added to the fourteen previous specimens known. P. L. Jones reports one found dead May 1, 1898; a female and two fresh eggs that proved infertile, June 27, 1898; a young male caught by a cat, September 12, 1898; a female and three eggs incubated about four days, June 5, 1899. All four cases were near Beulah, at less than 7,000 feet. Capt. D. B. Ingraham reports finding a female and two fresh eggs June 2, 1898, and two days later a female and two slightly incubated eggs, the latter within a hundred yards of where a female and three eggs were taken in 1897, near Beulah. Mr. C. E. Aiken reports two more specimens from Colorado Springs; one of these, taken on Fountain Creek, is the first summer specimen for the plains. There is one in the Carter collection, taken at Breckenridge, October 4, 1894. These make twenty-three records for Colorado and ten instances of nesting.

Page 80. 375b. **Bubo virginianus arcticus.** ARCTIC HORNED OWL.

Mr. Aiken reports a fine specimen killed near Colorado Springs, November 28, 1898. Another one said to have been seen. These notes of course refer to the lighter mountain form.

Up to the time of the issue of this bulletin, the A. O. U. has come to no conclusion in regard to what name shall be applied to this variety.

Horned Owls are common at Breckenridge, but in Mr. Carter's quite extensive series there are none of the lighter form.

Page 80. 376. **Nyctea nyctea.** SNOWY OWL.

Has been reported to Mr. Carter as taken near Breckenridge. The most southern record to date in Colorado is one known by Mr. Baker to have been seen in the Wet Mountain valley.

Page 81. 378. **Speotyto cunicularia hypogæa.** BURROWING OWL.

One in the Carter collection, taken in Middle Park.

Page 81. 379. **Glaucidium gnoma.** PYGMY OWL.

Mr. Carter reports it as breeding at Breckenridge.

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Page 81. 385. **Geococcyx californianus.** ROAD-RUNNER.

There is one in the Carter collection that was taken on the Arkansas above Canon City. Mr. Carter saw one several years ago near Littleton, which is the most northern record for the State.

Page 82. 387a. **Coccyzus americanus occidentalis.** CALIFORNIA CUCKOO.

Taken by Mr. Carter in Middle Park.

Page 82. 390. **Ceryle alcyon.** BELTED KINGFISHER,

Mr. L. B. Gilmore records one that wintered in 1897-8 near the outlet of Sweetwater Lake, at about 8,000 feet.

Breeds at Breckenridge.

Page 82. 393e. **Dryobates villosus monticola.** ROCKY MOUNTAIN HAIRY WOODPECKER.

This the present name given to the common form that occurs in Colorado. Breeds at Breckenridge.

Page 82. 394c. **Dryobates pubescens medianus.** DOWNY WOODPECKER.

If the eastern form really occurs in Colorado, it would be of this subspecies.

Page 83. 394b. **Dryobates pubescens homorus.** BATCHELDER'S WOODPECKER.

Page 83. 401b. **Picoides americanus dorsalis.** ALPINE THREE-TOED WOODPECKER.

Page 83. 402a. **Sphyrapicus varius nuchalis.** RED-NAPED SAPSUCKER.

Page 84. 404. **Sphyrapicus thyroides.** WILLIAMSON'S SAPSUCKER.

The last four species are all represented in Mr. Carter's collection, and have been taken by him as breeders at Breckenridge.

Page 84. 405a. **Ceophlœus pileatus abieticola.** NORTHERN PILEATED WOODPECKER.

This becomes now the name of the Colorado bird.

Page 84. 406. **Melanerpes erythrocephalus.** RED HEADED WOODPECKER.

Taken at Breckenridge by Mr. Carter, but not known to breed there.

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Page 84. 408. **Melanerpes torquatus.** LEWIS'S WOODPECKER.

The statement of breeding for this species is a misprint. It should be: Breeds late in May. In calling attention to the error, Mr. Walter Blanchard of Boulder, writes that the earliest eggs he has known at Boulder were May 10, and the latest, June 14. Mr. Carter has seen the birds at Breckenridge, but does not know of their nesting there.

Page 84. 409. **Melanerpes carolinus.** RED-BELLIED WOODPECKER.

One was taken by Mr. C. E. Aiken near Limon in May, 1899.

Page 85. 412a. **Colaptes auratus luteus.** NORTHERN FLICKER.

It is probable that the Colorado bird should be referred to this form.

Page 85. 413. **Colaptes cafer.** RED SHAFTED FLICKER.

Breeds at Breckenridge.

Page 85. 418. **Phalænoptilus nuttallii.** POOR-WILL.

Mr. Carter reports their breeding in Middle Park.

Page 85. 420a. **Chordeiles virginianus henryi.** WESTERN NIGHTHAWK.

Page 86. 425. **Aeronautes melanoleucus.** WHITE-THROATED SWIFT.

Both these last two breed at Breckenridge.

Page 86. 429. **Trochilus alexandri.** BLACK-CHINNED HUMMINGBIRD.

Mr. Wm. Cross took a fine male at Glenwood Springs in 1898. This is the most northeasterly record to date.

Page 86. 432. **Selasphorus platycercus.** BROAD-TAILED HUMMINGBIRD.

Breeds at Breckenridge.

Page 86. 433. **Selasphorus rufus.** RUFOUS HUMMINGBIRD.

One was taken by Mr. Carter at Breckenridge, and it probably breeds there, though he has never found its nest.

Page 87. 436. **Stellula calliope.** CALLIOPE HUMMINGBIRD.

One of the most surprising specimens in Mr. Carter's collection is a fine Calliope Hummer taken near Breckenridge, June

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30, 1882, at an altitude of about 9,500 feet. This is the second record for Colorado.

Page 87. 444. **Tyrannus tyrannus.** KINGBIRD.

Breeds in Middle Park, according to Mr. Carter.

Page 87. 447. **Tyrannus verticalis.** ARKANSAS KINGBIRD.

Mr. Carter has seen them at Breckenridge in migration, and knows of their breeding in Middle Park.

Page 87. 448. **Tyrannus vociferans.** CASSIN'S KINGBIRD.

Occurs in migration at Breckenridge and breeds only a little lower, nearly to 9,000 feet.

Page 87. 454. **Myiarchus cinerascens.** ASH-THROATED FLYCATCHER.

The known northeastern range of this bird has been considerably extended by a specimen in the Bond collection, taken at Cheyenne, Wyoming, June 6, 1896.

Page 88. 457. **Sayornis saya.** SAY'S PHŒBE.

Mr. Carter has taken it at Breckenridge, but does not know of its breeding there.

Page 88. 459. **Contopus borealis.** OLIVE SIDED FLYCATCHER.

Page 88. 462. **Contopus richardsonii.** WESTERN WOOD PEWEE.

Page 88. 464. **Empidonax difficilis.** WESTERN FLYCATCHER.

Page 88. 466. **Empidonax traillii.** TRAILL'S FLYCATCHER.

Of these four, the first three breed at Breckenridge, while the last occurs there in migration, but has not been noted breeding.

Page 89. 468. **Empidonax hammondi.** HAMMOND'S FLYCATCHER.

Known by Mr. Carter to breed as high as Dillon at 9,000 feet.

Page 89. 469. **Empidonax wrightii.** WRIGHT'S FLYCATCHER.

Occurs at Breckenridge in migration, but not known by Mr. Carter to breed there.

Page 89. 474c. **Otocoris alpestris arenicola.** DESERT HORNED LARK.

During February, 1899, Colorado experienced the most severe weather on record. Along the foothills from Fort Collins

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to Colorado Springs the mercury fell to thirty below zero F. or lower. For two weeks or more, countless thousands of the Horned Larks flocked into the towns in search of food, and many thousands died of cold and hunger. Around the flour mills and elevators they came in clouds. Many persons made special provision for feeding them, one man giving them more than three thousand pounds of grain. Mr. Carter ascribes to this form the birds that breed at Breckenridge.

Page 89. 475. **Pica pica hudsonica.** AMERICAN MAGPIE.

Mr. Carter found them at Breckenridge breeding almost to timber line, at 10,500 feet.

Page 90. 478b. **Cyanocitta stelleri macrolopha.** LONG-CRESTED JAY.

At Boulder, Mr. Blanchard has taken the earliest sets of eggs May 11, 1896, May 15, 1897, and May 10, 1898.

Mr. Carter notes their breeding at Breckenridge.

Page 90. 484a. **Perisoreus canadensis capitalis.** ROCKY MOUNTAIN JAY.

Page 91. 486. **Corvus corax sinuatus.** AMERICAN RAVEN.

Both breed at Breckenridge.

Page 91. 487. **Corvus cryptoleucus.** WHITE-NECKED RAVEN.

There is one in the Carter collection, taken at Dillon in the fall of 1872. At that time they were quite common, Mr. Carter says, but have since disappeared.

One was seen by Mr. A. D. Baker in the Wet Mountain valley a few years ago. Mr. C. E. Aiken learned at Limon, out on the plains east of Colorado Springs, that one was seen there about ten years ago.

Page 92. 488. **Corvus americanus.** AMERICAN CROW.

Has been taken by Mr. Carter at Breckenridge, but is not known to breed there. Usually seen singly.

Page 92. 491. **Nucifraga columbiana.** CLARKE'S NUT-CRACKER.

Breeds at Breckenridge.

Page 93. 492. **Cyanocephalus cyanocephalus.** PINON JAY.

Mr. Carter has seen them at Breckenridge in the fall, but during the summer season has not found them there or in either Middle or South Park.

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Page 93. 494. **Dolichonyx oryzivorus.** BOBOLINK.

To the few records of this bird in Colorado Mr. Carter now adds two more. One was taken in Middle Park May 20, 1884, at 7,000 feet, and one taken in South Park May 21, 1876, at about 8,000 feet. These are farther west and at a higher altitude than any previous Colorado records. Mr. C. E. Aiken saw a female at Limon in May, 1899.

Page 93. 495. **Molothrus ater.** COWBIRD.

Page 93. 497. **Xanthocephalus xanthocephalus.** YELLOW-HEADED BLACKBIRD.

Page 94. 498. **Agelaius phœniceus.** RED-WINGED BLACKBIRD.

All three of these Blackbirds have been found by Mr. Carter breeding in Middle and South Parks, and all have been taken at Breckenridge, but only in migration.

Page 94. 501b. **Sturnella magna neglecta.** WESTERN MEADOWLARK.

Breeds at Breckenridge.

Page 95. 508. **Icterus bullocki.** BULLOCK'S ORIOLE.

Seen by Mr. Carter in Middle Park, but contrary to what would be expected, he has never seen it at Breckenridge.

Page 95. 510. **Scolecophagus cyanocephalus.** BREWER'S BLACKBIRD.

Breeds at Breckenridge.

Page 95. 514a. **Coccothraustes vespertinus montanus.** WESTERN EVENING GROSBEAK.

The record is now complete for Colorado for every month in the year. They had been seen in the State from the first week in August until late in May. On June 19, 1898, Mr. C. E. Aiken found a flock of twenty-five to thirty birds in the foothills near Colorado Springs. He killed five males. The testicles of each were the size of a bean, and it was evident that the birds were breeding in the mountains and had come down to feed on the insect larvæ that were ravaging the young oak leaves. The year is completed by the record of Mr. L. A. Test of the Agricultural College at Fort Collins, who on July 22, 1899, and again the next day, in Estes Park, saw a party of eight, apparently three old birds and five young ones. Mr. P. L. Jones of Beulah reports that during May and June, 1898, these birds were constantly around his premises. Late in June he saw a flock of seventeen,

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composed of male and female and some birds which seemed to to be young-of-the-year, but were not captured for certain identification.

On the strength of these records this species will be classed as resident in Colorado.

Page 96. 515a. **Pinicola enucleator montana.** ROCKY MOUNTAIN PINE GROSBEAK.

Breeds at Breckenridge.

Page 96. 518. **Carpodacus cassini.** CASSIN'S PURPLE FINCH.

An abundant breeder at Breckenridge. Mr. Carter once found a male in immature plumage breeding with a mature female.

Page 97. 521a. **Loxia curvirostra strickiandi.** MEXICAN CROSSBILL.

A female or young-of-the-year male was seen by the present writer at Lamar, July 15, 1898. It seemed in perfect health and was probably an accidental wanderer who found himself here on the plains, one hundred and fifty miles east of the foothills. Breeds at Breckenridge.

Page 97. 524. **Leucosticte tephrocotis.** GRAY-CROWNED LEUCOSTICTE.

Page 98. 524a. **Leucosticte tephrocotis littoralis.** HEPBURN'S LEUCOSTICTE.

Page 98. 526. **Leucosticte australis.** BROWN-CAPPED LEUCOSTICTE.

Page 98. 528. **Acanthis linaria.** REDPOLL.

All four of these species have been taken in migration at Breckenridge by Mr. Carter, while the Brown-capped Leucosticte is an abundant breeder on the mountain tops above Breckenridge.

Page 98. 229. **Astragalinus tristis.** AMERICAN GOLDFINCH

Mr. Carter considers this a rare bird at Breckenridge, where he has seen it only in migration.

Page 99. Add. 529a. **Astragalinus tristis pallidus.** WESTERN GOLDFINCH.

Migratory; probably common. It is undoubtedly a summer resident, but until this fact is definitely ascertained it will be classed among the migrants according to the present record. Added to Colorado birds by Mr. C. E. Aiken, who writes:

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"This paler Western Goldfinch occurs in Colorado as well as the typical eastern form to which all have heretofore been referred. I am not able at present to define their relative range or abundance with certainty. *Pallidus* is an early spring migrant along the eastern base of the mountains, and quite likely may be the alpine breeder. *Tristis* probably is a summer visitor from the southeast, occupying the plains to the base of the mountains. I have obtained both forms at Colorado Springs, and *tristis* one hundred miles eastward. Examples of both forms, which I recently sent to the American Museum of Natural History, have been kindly identified by Mr. Chapman with the concurrence of Dr. Allen."

Page 99. 530. **Astragalinus psaltria.** ARKANSAS GOLDFINCH.

Mr. Wm. Cross found this form breeding at Glenwood Springs during the summer of 1898. Mr. Aiken saw a very early flock at Colorado Springs May 13, 1898.

Page 99. 530a. **Astragalinus psaltria arizonæ.** ARIZONA GOLDFINCH.

Found by Mr. Wm. Cross breeding at Glenwood Springs during the summer of 1898. This is the most northwestern record in Colorado.

Page 99. Add. 530b. **Astragalinus psaltria mexicanus.** MEXICAN GOLDFINCH.

One taken by Mr. A. T. Allen in Denver and identified by Prof. J. A. Allen. There is also one in Mr. C. E. Aiken's collection taken near Colorado Springs. Near Trinidad, in June, 1898, the present writer is very sure that he saw two of them, though he failed to secure either of them. The species is entered as seen in summer but not known to breed. This is according to the present record, but it is with the belief that the species occurs at Trinidad as a regular summer resident.

Page 99. 533. **Spinus pinus.** PINE SISKIN.

One of the few nests ever found on the plains is the one taken by Mr. F. M. Dille in the outskirts of Denver during the summer of 1898. Mr. Carter has taken it at Breckenridge.

Page 99. 000. **Passer domesticus.** EUROPEAN HOUSE SPARROW.

Miss Myra Eggleston reports that they reached Grand Junction during the fall of 1899, a flock of a dozen being seen. This is the first record for Colorado west of the range, and there

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is nothing to indicate whether these birds reached Grand Junction from eastern Colorado or have come eastward from Utah. The distance is less from where they occur in Utah, and the mountain passes much lower.

Page 100. 534. **Passerina nivalis.** SNOWFLAKE.

Mr. Carter took one December 28, 1894, between Breckenridge and Middle Park at about 8,000 feet.

Page 100. 536a. **Calcarius lapponicus alascensis.** ALASKAN LONGSPUR.

This is the new name for the form of the Lapland Longspur that occurs in Colorado. It was seen but once by Mr. Carter at Breckenridge, where he took one, March 21, 1894, in the midst of a snowstorm. One has been seen by Mr. Baker in the Wet Mountain valley at over 8,000 feet.

Page 101. 540a. **Poœcetes gramineus confinis.** WESTERN VESPER SPARROW.

Page 101. 542b. **Ammodramus sandwichensis alaudinus.** WESTERN SAVANNA SPARROW.

Both breed at Breckenridge.

Page 102. Add. 548. **Ammodramus leconteii.** LECONTE'S SPARROW.

The rarest find in the Carter collection is a specimen of this Sparrow, taken at Breckenridge October 24, 1886. This is the first record for Colorado, and its occurrence in the mountains three hundred miles west of its usual prairie home is of course accidental. This is the only record in the United States west of the main range, except the one noted by Merrill, *Auk, XV.* 1898, *p. 16*, taken in Idaho. Though Merrill's bird was reported first, Carter's was taken many years the earlier.

Page 102. 552a. **Chondestes grammacus strigatus.** WESTERN LARK SPARROW.

Breeds at Breckenridge.

Page 102. 553. **Zonotrichia querula.** HARRIS'S SPARROW.

The second record for Colorado of this bird is the one seen by the present writer at Holly, May 10, 1898. It was migrating in company with White-crowned Sparrows.

Page 102. 554. **Zonotrichia leucophrys.** WHITE-CROWNED SPARROW.

Breeds at Breckenridge.

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Page 103. 559a. **Spizella monticola ochracea.** WESTERN TREE SPARROW.

Occurs at Breckenridge in migration.

Page 103. 560a. **Spizella socialis arizonæ.** WESTERN CHIPPING SPARROW.

Breeds at Breckenridge.

Page 104. Add. [563a. **Spizella pusilla arenacea.** WESTERN FIELD SPARROW.

"Great Plains, from Texas to Montana and Dakota."—(A. O. U.) A common summer resident of Kansas and Nebraska. Undoubtedly occurs on the plains of extreme eastern Colorado, but has not yet been reported.]

Page 104. 566. **Junco aikeni.** WHITE-WINGED JUNCO.

Page 105. 567b. **Junco hyemalis connectens.** SHUFELDT'S JUNCO.

Both taken at Breckenridge in migration.

Page 105. Add. 567.1. **Junco montanus.** MONTANA JUNCO.

This new form was recently described by Mr. Ridgway, who writes: "In our somewhat extensive series of *Junco montanus*, I find only one specimen from Colorado. This is a female, No. 109,943, U. S. N. M., collected at Pueblo, October 29, 1886, by C. W. Beckham. There are several examples from New Mexico and Arizona; all fall and winter birds." Mr. C. E. Aiken took this form at Ramah in February, 1899. He also has several specimens in his collection taken March 2, March 27 and October 25. The species therefore stands in the Colorado list as: Winter visitant, not uncommon; arrives the last of October and remains until late in March.

Page 105. 569. **Junco caniceps.** GRAY-HEADED JUNCO.

Breeds abundantly at Breckenridge, and in 1898 one nested under the eaves of Mr. Carter's house. A very late record for the plains was one taken by Mr. C. E. Aiken at Limon on May 25, 1899.

Page 106. 573a. **Amphispiza bilineata deserticola.** DESERT SPARROW.

This is the name now given to the bird that was formerly entered as the Black-throated Sparrow. Mr. P. L. Jones reports finding a nest with young near Canon City in 1888. This is the only time he saw the bird there in five years' residence.

Page 106. Add. [578. **Peucæa cassini.** CASSIN'S SPARROW.

"Central and western Kansas, southward and westward through Texas, New Mexico, Arizona and southern Nevada."—(A. O. U.) It would be difficult

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to have any bird a rather common summer resident over the western half of Kansas, also common in New-Mexico at the same season, and not have it occur in southeastern Colorado. But up to the present time no one has found it in this State.]

Page 107. 581b. **Melospiza fasciata montana.** MOUNTAIN SONG SPARROW.

Mr. Carter has taken it at Breckenridge only in migration. On the Blue river, at 7,500 feet, he took the nest and eggs July 5, 1877. He has never known it to nest above 8,000 feet.

Page 107. 583. **Melospiza lincolni.** LINCOLN'S SPARROW.

Breeds at Breckenridge.

Page 107. 585c. **Passerella iliaca schistacea.** SLATE-COLORED SPARROW.

A mounted specimen in Mr. Carter's collection was taken near the mouth of the Blue river in Grand county, July 5, 1877, at nearly 7,000 feet. This is one more summer record for Colorado, and the highest altitude at which it has yet been reported.

Page 108. 588a. **Pipilo maculatus megalonyx.** SPURRED TOWHEE.

Mr. Blanchard has found some eggs at Boulder as early as May 10. Mr. Carter has found it breeding nearly to Breckenridge.

Page 108. 592.1. **Oreospiza chlorura.** GREEN-TAILED TOWHEE.

This is the new number given to this species, hence it should come just after Abert's Towhee.

Mr. Carter has found it breeding as far up as Dillon, at 9,000 feet.

Page 108. 596. **Zamelodia melanocephala.** BLACK-HEADED GROSBEAK.

Found by Mr. Carter breeding in Middle Park and on the Blue river up to 8,500 feet.

Page 109. 597a. **Guiraca cærulea lazula.** WESTERN BLUE GROSBEAK.

Page 109. 598. **Cyanospiza cyanea.** INDIGO BUNTING.

Mr. Wm. Link saw several at Fort Collins about the middle of May, 1900. One was taken and is now mounted. They stayed round the premises for several days, and Mr. Link thought he saw three of them again in his yard May 30. This is the third record for Colorado.

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Page 109. 599. **Cyanospiza amœna.** LAZULI BUNTING.

Mr. Carter has not found it breeding higher than Middle Park.

Page 109. 604. **Spiza americana.** DICKCISSEL.

Mr. P. L. Jones of Beulah, reports finding the nest and eggs at Canon City in 1890. He saw the birds there during several years.

Page 109. 605. **Calamospiza melanocorys.** LARK BUNTING.

Found by Mr. Carter breeding at Dillon at 9,000 feet.

Page 110. 607. **Piranga ludoviciana.** LOUISIANA TANAGER.

Breeds at Breckenridge.

Page 110. 608. **Piranga erythromelas.** SCARLET TANAGER.

One was reported to Mr. C. E. Aiken as seen at Limon in May, 1899.

Page 110. 611. **Progne subis.** PURPLE MARTIN.

Miss Myra Eggleston writes that Purple Martins are common at Grand Junction, but do not breed in town, preferring the banks of the river not far distant.

Page 110. 612. **Petrochelidon lunifrons.** CLIFF SWALLOW.

Page 111. 613. **Hirundo erythrogaster.** BARN SWALLOW.

Page 111. 614. **Tachycineta bicolor.** TREE SWALLOW.

Page 111. 615. **Tachycineta thalassina.** VIOLET-GREEN SWALLOW.

All these four breed in the mountains, though Mr. Carter has never seen the Tree Swallow breeding quite as high as Breckenridge, where the others are common.

Page 111. 618. **Ampelis garrulus.** BOHEMIAN WAXWING.

Seen at Breckenridge in winter.

Page 112. 621. **Lanius borealis.** NORTHERN SHRIKE.

Page 112. 622a. **Lanius ludovicianus excubitorides.** WHITE-RUMPED SHRIKE.

Both of these have been taken by Mr. Carter, either at or near Breckenridge.

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Page 112. 624. **Vireo olivaceus.** RED-EYED VIREO.

The Bond collection at Cheyenne, Wyoming, contains a specimen taken there May 26, 1889, and Rev. F. N. White saw one there May 20, 1899.

Page 112. 627. **Vireo gilvus.** WARBLING VIREO.

Page 112. 629b. **Vireo solitarius plumbeus.** PLUMBEOUS VIREO.

Both these species breed at Breckenridge.

Page 112. Add. [630. **Vireo atricapillus.** BLACK-CAPPED VIREO.

"Central and western Texas, from the Rio Grande north to southwestern Kansas."—(A. O. U.) Should be found along the Cimarron river in southeastern Colorado.]

Page 112. Add. [631. **Vireo noveboracensis.** WHITE-EYED VIREO.

"Eastern United States, west to the Rocky Mountains."—(A. O. U.) This should include Colorado, but there is no record known to the present writer from this State.]

Page 112. Add. [633. **Vireo bellii.** BELL'S VIREO.

"Upper Mississippi valley and Great Plains."—(A. O. U.) "From Illinois and Minnesota west to the eastern base of the Rocky Mountains."—(Goss.) "Inhabits the middle parts of the United States, from Illinois and Minnesota west to the foothills."—(Lantz.)

One would suppose from these statements that it was not uncommon in Colorado, and possibly it is not, but there is no record for it here up to the present time.]

Page 113. 644. **Helminthophila virginiæ.** VIRGINIA'S WARBLER.

Taken by Mr. Carter in both Middle and South Parks, where it breeds. Also taken by Mr. C. E. Aiken in May, 1899, at Limon, far out on the plains.

Page 113. 647. **Helminthophila peregrina.** TENNESSEE WARBLER.

There is one in the Bond collection, taken at Cheyenne, Wyoming, May 24, 1888.

One was taken by Mr. C. E. Aiken near Limon in May, 1899.

Page 114. 648. **Compsothlypis americana.** PARULA WARBLER.

The known northern range of this species is extended nearly two hundred miles by a specimen taken at Cheyenne, Wyoming, May 30, 1888, and now in the Bond collection.

Page 114. 652. **Dendroica æstiva.** YELLOW WARBLER.

Breeds in Middle Park and at Breckenridge.

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Page 115. 656. **Dendroica audubonl.** AUDUBON'S WARBLER.
Breeds at Breckenridge.

Page 115. 661. **Dendroica striata.** BLACK-POLL WARBLER.
There is a specimen taken by Mr. Bond at Cheyenne, Wyoming, May 11, 1888, and Rev. F. N. White saw one there May 15, 1899.

Page 116. 668. **Dendroica townsendi.** TOWNSEND'S WARBLER.
A young male was taken at Cheyenne, Wyoming, and is now in the Bond collection.

Page 116. 674. **Seiurus aurocapillus.** OVEN-BIRD.
On June 5, 1898, Mr. C. E. Aiken shot at Ramah a female with ovaries so extended that there seemed no doubt of its breeding. On the strength of this record the bird is included among the Colorado breeders.

Page 116. 675a. **Seiurus noveboracensis notabilis.** GRINNELL'S WATER-THRUSH.
One in the Bond collection at Cheyenne, Wyoming.

Page 116. Add. 678. **Geothlypis agilis.** CONNECTICUT WARBLER.
Migratory; rare or accidental. The first and only record for Colorado is the one taken by Mr. C. E. Aiken, who writes:
"On May 24, 1899, I shot a male in a clump of willows bordering a water hole at Lake, Lincoln county, about one hundred miles northeast of Colorado Springs. This unexpected capture adds an interesting eastern bird to the fauna of Colorado, and extends the known range of the species several hundred miles to the westward."

Page 116. 680. **Geothlypis tolmiei.** MACGILLIVRAY'S WARBLER.
Breeds in Middle Park, according to Mr. Carter.

Page 117. Add. 681. **Geothlypis trichas.** MARYLAND YELLOW-THROAT.
One taken by Mr. C. E. Aiken at Colorado Springs, May 31, 1898, and identified by Mr. Ridgway. This is the eastern form, rarely coming west to the plains.

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Page 117. 681a. **Geothlypis trichas occidentalis.** WESTERN YELLOW-THROAT.

One was seen May 8, 1898, by Mr. L. B. Gilmore at Sweetwater Lake at 8,000 feet.

Mr. Carter has found it breeding at Dillon at 9,000 feet.

Page 117. 685. **Wilsonia pusilla.** WILSON'S WARBLER.

Page 117. 685a. **Wilsonia pusilla pileolata.** PILEOLATED WARBLER.

Its occurrence in Colorado will now be changed to: Summer resident; not uncommon.

There is in the Carter collection a specimen, quite typical, that was taken with nest and eggs at the eastern side of South Park, July 3, 1878. Mr. C. E. Aiken believes that this form is fully as common in Colorado as the eastern *pusilla*.

Page 118. Add. 686. **Wilsonia canadensis.** CANADIAN WARBLER.

Migratory; rare or accidental. Added to the Colorado list by Mr. C. E. Aiken in the following note:

"The range of this species is extended westward nearly to the Rocky Mountain range by my capture of a male at Lake, Lincoln county, May 23, 1899.

Page 118. 678. **Setophaga ruticilla.** AMERICAN REDSTART.

Breeds in Middle Park. The foregoing records show that of the twenty-nine Warblers known to occur in Colorado, but three have been taken breeding at Breckenridge by Mr. Carter, showing how few of these birds go up into the high mountains.

There are twenty-five Warblers given in the last edition of the A. O. U. Check List whose range is said to be "Eastern United States" or "Eastern United States to the Plains," thus not including Colorado in their habitat. These have all been taken in Kansas, and eleven of them have been found in Colorado. Since these eleven include several that would have been considered as little likely as any to be found in this State, we may expect that sooner or later most of the other fourteen will be noted in Colorado. Those not yet found here are *Protonotaria citrea, Helmitherus vermivorus, Helminthophila pinus, Helminthophila ruficapilla, Dendroica pensylvanica, Dendroica blackburniæ, Dendroica dominica albilora, Dendroica virens, Dendroica vigorsii, Dendroica discolor, Seiurus motacilla, Geothlypis formosa, Geothlypis philadelphia, and Wilsonia mitrata.*

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Page 118. Add. [700. **Anthus spragueii.** SPRAGUE'S PIPIT.

It seems strange that there is no record of this bird for Colorado, when there are three specimens in the Bond collection, taken at Cheyenne, Wyoming, April 24, 1888, and it was undoubtedly seen there by Rev. F. N. White, April 29, 1899. It is unreasonable not to suppose that these birds crossed Colorado to reach Cheyenne. Moreover they are said to be: "Rare in eastern Kansas, common in the western part of the State."—(Lantz.) It is practically certain then that they occur in eastern Colorado, and that before long some one will find them there.]

Page 118. 701. **Cinclus mexicanus.** AMERICAN DIPPER.

Mr. Blanchard has taken nests on Boulder Creek four miles above Boulder at about 5,500. Two sets were taken, May 6 and May 12, 1898. All the sets he ever found in that locality were between May 1 and May 15. It is thus evident that these birds at the lower altitude nested earlier than is customary at the usual altitude.

Mr. Carter found the Dipper breeding at Breckenridge.

Page 119. 702. **Oroscoptes montanus.** SAGE THRASHER.

Mr. Carter has found them at Dillon at 9,000 feet, but does not know of their breeding higher than Middle Park.

Page 119. 703. **Mimus polyglottos.** MOCKINGBIRD.

The present writer saw two at the San Luis Lakes and one at La Jara on June 17 and 18, 1898. Mr. D. E. Newcomb of La Jara says that some years he sees them several times; other years they are absent. Miss Myra Eggleston reports them as breeding at Grand Junction. This completes the record for the whole southern half of Colorado, from Kansas to Utah.

There is one in the Carter collection, taken at Breckenridge August 12, 1891. This is 1,500 feet higher than any previous record, and was undoubtedly a wanderer.

Page 119. 704. **Galeoscoptes carolinensis.** CATBIRD.

The date of nesting should read the latter part of May, instead of June.

Mr. Carter reports it as a rare breeder in Middle Park.

Page 120. 715. **Salpinctes obsoletus.** ROCK WREN.

Breeds at Breckenridge.

Page 120. 719b. **Thryomanes bewickii leucogaster.** BAIRD'S WREN.

Page 120. 721b. **Troglodytes aedon aztecus.** WESTERN HOUSE WREN.

Breeds at Breckenridge.

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Page 121. 722. **Anorthura hiemalis.** WINTER WREN.

One taken by Dr. W. H. Bergtold in Denver, July 8, 1896. This is the lowest summer record.

Page 121. Add. [724. **Cistothorus stellaris.** SHORT-BILLED MARSH WREN. One in the Bond collection, taken at Cheyenne, Wyoming, April 14, 1889.]

Page 121. 725c. **Cistothorus palustris plesius.** WESTERN MARSH WREN.

Known by Mr. Carter to breed in South Park.

Page 121. 726b. **Certhia familiaris montana.** ROCKY MOUNTAIN CREEPER.

Page 122. 727a. **Sitta carolinensis aculeata.** SLENDER-BILLED NUTHATCH.

Page 122. 728. **Sitta canadensis.** RED-BREASTED NUTHATCH.

Page 122. 730. **Sitta pygmæa.** PYGMY NUTHATCH.

Page 122. 735a. **Parus atricapillus septentrionalis.** LONG-TAILED CHICKADEE.

Page 123. 738. **Parus gambeli.** MOUNTAIN CHICKADEE.

These last six species are all common birds of the mountains and have all been taken by Mr. Carter at Breckenridge. The present writer found the Mountain Chickadee common and evidently breeding at Trinidad, June 15, 1898. This is only 6,000 feet, much lower than this species usually nests.

Page 123. 744. **Psaltriparus plumbeus.** LEAD-COLORED BUSH-TIT.

During the summer of 1897 Capt. D. P. Ingraham took three sets of eggs near Beulah. Mr. C. E. Aiken has seen them occasionally in large flocks in winter in the foothills northeast of Canon City. He took a nest and five fresh eggs there May 9, 1876. Mr. Wm. Cross took the nest and six eggs at Glenwood Springs during the summer of 1898.

Page 123. 749. **Regulus calendula.** RUBY-CROWNED KINGLET.

A nest and seven eggs have been presented to the State Historical and Natural History Society of Denver, that were taken by Mr. Evan Lewis at Boswell, near Twin Lakes, June 12, 1898, at an elevation of 11,000 feet.

The lowest Mr. Carter has ever known of their nesting was at 7,000 feet, in Middle Park.

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Page 124. 754. **Myadestes townsendii.** TOWNSEND'S SOLITAIRE.

Breeds above timber line near Breckenridge.

Page 124. 756a. **Hylocichla fuscescens salicicola.** WILLOW THRUSH.

Page 124. 758a. **Hylocichla ustulata swainsoni.** OLIVE-BACKED THRUSH.

Page 125. 759. **Hylocichla aonalaschkæ.** DWARF HERMIT THRUSH.

One taken by Mr. C. E. Aiken during the season of 1898, and three during the spring of 1899.

Page 125. 759a. **Hylocichla aonalaschkæ auduboni.** AUDUBON'S HERMIT THRUSH.

Breeds at Breckenridge.

Page 125. 759b. **Hylocichla aonalaschkæ pallasii.** HERMIT THRUSH.

Page 126. 761a. **Merula migratoria propinqua.** WESTERN ROBIN.

Breeds at Breckenridge.

Page 126. 766. **Sialia sialis.** BLUEBIRD.

Mr. Bond says that the Eastern Bluebird is a regular summer visitant to the City Park in Cheyenne, Wyoming.

Page 126. 767a. **Sialia mexicana bairdi.** CHESTNUT-BACKED BLUEBIRD.

Mr. Carter has found it breeding in South Park, but never as high as Breckenridge.

Page 126. 768. **Sialia arctica.** MOUNTAIN BLUEBIRD.

Breeds at Breckenridge.

Page 148. *B. Species that breed on the plains.* Omit

Helminthophila peregrina.

Page 149. 7. **Migrants.** Omit

Helminthophila peregrina.

Page 155. 8. **Gavia adamsii.** YELLOW-BILLED LOON.

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Page 156. 160. **Somateria dresseri.** AMERICAN EIDER.

Further research has shown that the specimen mentioned at the capitol at Denver was taken outside of Colorado.

Page 162. 418a. **Phalænoptilus nuttallii nitidus.** FROSTED POOR-WILL.

The two specimens taken by Mr. Aiken have been later identified as true *nuttallii*.

Page 167. 595. **Zamelodia ludoviciana.** ROSE-BREASTED GROSBEAK.

Page 168. 647. **Helminthophila peregrina.** TENNESSEE WARBLER.

This is now withdrawn from the list of Colorado breeders since Mr. Aiken has satisfied himself that the record is a misidentification for Virginia's Warbler.

ADDENDUM.

While the last pages of this bulletin are passing through the press, the *Auk* for July, 1900, is received, necessitating the following addition:

Page 186. Add. Aiken, C. E. Seven New Birds for Colorado. *Auk, XVII.* 1900, *p. 298.*

Adds to the Colorado list, *Gavia arctica, Ardea egretta, Syrnium nebulosum, Astragalinus tristis pallidus, Geothlypis agilis, Geothlypis trichas, Wilsonia canadensis.*

The records of these birds for Colorado have been given in this bulletin, but since the article in the *Auk* was published first, it becomes the first record of these birds for Colorado, instead of this bulletin.

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Bulletin 57. **July, 1900.**

The Agricultural Experiment Station

OF THE

Agricultural College of Colorado.

FARM NOTES

Alfalfa, Corn, Potatoes and Sugar Beets

—BY—

Bulletin No. 56, being a technical bulletin, is printed in a small edition and is not sent to the general mailing list. It will be sent to individuals upon request.

The bulletin is a second appendix to No. 37 on "The Birds of Colorado," by Professor W. W. Cooke, of which No. 44 was the first appendix. It gives lists of birds that have been found in Colorado, with localities where they have been found, and some notes.

Some who receive this bulletin may have a copy of No. 37 which they do not need, or are willing to spare for the benefit of others who have greater use for it. Requests come from many who have good reason to desire a copy, which the Station cannot supply. Send to the Station or address

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Bulletin 57. **July, 1900.**

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Alfalfa, Corn, Potatoes and Sugar Beets

—BY—

W. W. COOKE

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FARM NOTES.

By W. W. COOKE.

The following bulletin contains the records of various tests that have been made on the college farm during the years 1894 to 1899. They are grouped under the following headings:

I. Alfalfa.

a—Losses in cutting and curing.
b—Losses in the stack and in the barn.
c—Alfalfa ensilage.
d—Three methods of handling alfalfa.
e—Top-dressing alfalfa.
f—Moisture in green alfalfa.
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I. ALFALFA.

A—LOSSES IN CUTTING AND CURING.

It has long been known that there was some loss in making alfalfa hay. Part of this loss is chemical, arising from the fermentation of the hay when exposed to rains during the curing process. The rest of the loss is mechanical and consists of the breaking off of the leaves and smaller ends of the branches when the alfalfa is hauled after it becomes dry. To overcome the latter loss, so far as possible, it is customary to rake the alfalfa while it is yet far from dry, and, particularly, early in the morning while the dew still makes it damp and pliable. It is also cocked while still quite moist, and allowed to dry out slowly. Both these methods, while saving the mechanical losses, tend toward the increasing of the chemical losses through fermentation.

To ascertain the exact amount of these losses several experiments have been made in different years.

In the first set of tests, the field was divided into several long narrow strips. The whole field was cut at the same time, then every other strip was gathered up at once, weighed and three samples taken. The alternate plots were made into hay according to our usual methods. When fully cured this hay was brought to the barn, weighed and four samples taken. The weight of the first multiplied by the average composition of the samples gives the value of the alfalfa when cut; the weight of the hay when cured, multiplied by its average composition gives its value after curing. The supposition was made that the alfalfa left on the ground weighed the same and had the same composition as that gathered up. Since the number of plots was never less than ten and the size was quite large, it is probable that the error, if any, was quite small.

Three tests were made in this manner, and they illustrate the different conditions under which alfalfa hay is cured.

The first cutting was made May 28 and owing to several rains and considerable cloudy weather, it was not until June 12 that the hay was ready to go into the barn. This hay

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had a hard time of it, but no worse than often happens to the first cutting of alfalfa in northern Colorado. The plots gathered up at once on May 28 yielded at the rate of 16,553 pounds of green alfalfa per acre, which contained 23.2 per cent of dry matter or 3,840 pounds of dry matter per acre. After the fifteen days of hardship the final hay secured weighed 3,302 pounds per acre, with 86.0 per cent of dry matter or 2,839 pounds of dry matter per acre. Thus, of the original 3,840 pounds of dry matter, but 2,839 pounds were saved, showing a loss of 1,001 pounds per acre or 26.1 per cent.

In the second test the alfalfa was cut June 21, raked and cocked June 23, and brought to the barn June 28, or seven days after cutting. The only moisture on this hay was a small rain and a mere sprinkle, both coming after the hay was in the cock, and neither enough so that the hay had to be opened up to dry. This case represents the ordinary good conditions of the first crop of alfalfa in Colorado. At the time of cutting the field yielded at the rate of 16,258 pounds of alfalfa per acre, containing 30.3 of dry matter or 4,926 pounds of dry matter per acre. The hay put in the barn weighed 4,900 pounds per acre and was very dry, testing 90.3 per cent dry matter or 4,425 pounds of dry matter per acre. In this case, of the original 4,926 pounds of dry matter, 4,425 pounds were saved; a loss of 501 pounds per acre or a loss of 10. 2 per cent.

The third trial was made in September, under perfect weather conditions, the hay coming to the barn without having had a drop of moisture fall on it. The crop was the heaviest ever cut on the College farm in the fall. The green weight was 13,133 pounds per acre, containing 38.0 per cent dry matter, or 4,990 pounds dry matter per acre. This field produced, in the whole season, a little over seven and a half tons of hay per acre. When the experimental hay was put in the stack it weighed 5,097 pounds per acre and contained 93.0 per cent dry matter or 4,740 pounds of dry matter per acre. So, in this third trial there was a loss of but 5.1 per cent of the value of the hay in curing and stacking.

The other method used for making a test of this same point was to cut the field and at once gather up the alfalfa from sixteen different plots scattered over the field, each plot being twenty feet long and the width of the mower swath. It was considered that these sixteen plots of over a thousand square feet would represent the average of the field.

In the first test the alfalfa was cut June 8, raked June 12, cocked the 14th and taken to the barn June 16. The

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weather on June 9 and 10 was cloudy with some showers, but at this time the alfalfa had not yet dried much and it was but little injured by the rain. It showed a total loss of 9.0 per cent of value in the curing and gathering.

The next sample was cut June 15, raked June 17, cocked June 18 and gotten in the same day; all without a drop of rain. It also showed 9.0 per cent loss.

The third lot was cut June 22, raked and cocked June 24. That night a quarter of an inch of rain fell and the next day was showery. The hay was opened up, turned and recocked June 26 and taken to the barn June 28. It showed a loss of 13.0 per cent of dry matter.

Another field was cut June 15, raked June 18, cocked June 19 and gotten in June 22. The weather was perfect and the hay showed 11.0 per cent of loss. Still another field cut at about the same time and under the best of conditions, showed 10.0 per cent loss.

We thus have eight tests of the losses in curing and gathering alfalfa. They vary from 5.1 per cent to 26.1 per cent, with an average of 11.7 per cent.

It is probable that this average is not far from the real average of the losses on the alfalfa in Colorado that does not suffer any hard rain. The first test with a loss of 26.1 per cent, shows what may easily happen under bad conditions.

It is specially to be noted that the hay which was made in perfect weather shows about the same loss as that which had cloudy weather and light showers. The hay that dried most rapidly became so brittle that the mechanical losses of leaves and stem were fully equal to the losses by fermentation during the damper weather.

B—LOSSES OF ALFALFA IN THE STACK AND IN THE BARN.

A test was made to determine how much of its feeding value was lost by alfalfa hay after it was put in the stack and how much of that loss could be saved by putting the hay in a barn.

A field of alfalfa was all cut the same day, handled alike until made into well cured hay, then it was hauled and each two loads put alternately in the stack and in the barn. The stack was divided by slats into four layers and the hay in the barn into four corresponding layers. The hay in each layer was weighed separately and duplicate samples taken for analysis. This hay was the first cutting and was put in the stack June 15. It remained in the stack eight months and on

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February 16 all the layers of the stack and in the barn were again weighed and sampled. The stack was about the same height and width of the usual alfalfa stack in Colorado and its being shorter than the average scarcely affects the results.

As would be expected the top and bottom layers of the stack suffer more loss than the middle layers. The top layer lost about five per cent of its weight in spoiled hay and the bottom layer about the same per cent of waste hay that was so injured by the dampness of the ground as to be unsalable.

All the layers lost considerably in weight as follows:

LOSS OF WEIGHT IN STACK.

Layer.	Weight as put in June 15.	Weight when taken out Feb. 12.	Per cent of loss in weight.
Bottom	5048	4160	17.6
Second	4906	4244	13.5
Third	4754	3946	17.0
Top	4664	3554	23 8
Average	4843	3986	17.7

This loss, however, is largely due to the drying out of the water in the hay. As put up the hay averaged 18.9 per cent of water; as taken out this had dried to but 11.1 per cent of water. The changes that took place in the dry matter give these figures:

LOSS OF DRY MATTER IN STACK.

Layer.	Dry Matter as put in June 15.	Dry matter when taken out Feb. 12.	Per cent of loss in dry matter.
Bottom	4069	3593	11.7
Second	4031	3818	5.3
Third	4030	3550	11.9
Top	3585	3197	10.8
Average	3929	3539	10.0

This latter table does not show the loss in real feeding value, for both the top and the bottom layers had some hay that could not be used for feeding. If the amount of this spoiled hay is subtracted, it leaves the following as the losses of feeding value:

LOSS OF FEEDING VALUE IN STACK.

Layer.	Feeding value as put in June 15.	Feeding value when taken out Feb. 12.	Per cent of loss in feeding value.
Bottom	4069	3390	16 8
Second	4031	3818	5.3
Third	4030	3550	11 9
Top	3585	2997	16 1
Average	3929	3439	12.4

The results show that for every hundred pounds of hay

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put into the stack 82.3 pounds were taken out and for every hundred pounds of feeding value in the hay as put in the stack 12.4 pounds were lost and 87.6 pounds were saved. The loss is one-eighth; that is, for every eight tons of feeding value in the original hay, seven tons are saved and one lost.

Chemical analyses were made of the hay as put into the middle layers of the stack and as taken out. A comparison of the two analyses shows what changes took place in the hay during process of curing in the stack.

COMPOSITION OF THE STACKED HAY.

	As put in June 15.	As taken out February 12.
Water	16.6	10.0
Dry Matter	83.4	90.0
Analysis of Dry Matter-		
Ash	9.91	11.84
Ether Extract	1.25	1.34
Crude Protein	15.07	14.74
Crude Fiber	36.97	38.62
Nitrogen-free Extract	36.79	33 46

The analysis taken in connection with the weights shows that the following losses of food ingredients took place in these middle layers of the stack.

LOSS OF FOOD INGREDIENTS IN THE STACK.

	As put in June 15.	As taken out February 12.	Per cent of loss.
Ether Extract	101	99	2.0
Crude Protein	1214	1086	10.5
Crude Fiber	2978	2845	4.4
Nitrogen-free Extract	2964	2465	16.8
Total	7257	6495	10.5

Samples were also taken and analyzed of the load from the top of the stack and from the bottom. The analyses are given below in comparison with the composition of the alfalfa when put in the stack.

	Original.	Top of stack.	Bottom of stack
Ash	9.91	11.64	12.18
Ether Extract	1 25	1.47	1.77
Crude Protein	15.07	15.94	17.04
Crude Fiber	36.97	38.82	36.84
Nitrogen-free Extract	36.79	32.13	32.75

In the top of the stack the loss falls on both the protein and the extract matter, while at the bottom the loss is almost confined to the extract matter and crude fiber. In both cases the loss of carbohydrates is greater than in the middle layers.

The losses on the hay that was put in the barn show quite a different result:

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LOSS OF WEIGHT IN BARN.

Layer	Weight as put in June 15.	Weight when taken out February 12.	Per cent of loss in weight.
Bottom	3778	3480	7.9
Second	4752	4091	13.8
Third	4696	4103	12.6
Top	4236	3663	13.5
Average	4365	3834	12.2

Judging by these figures alone one would think that the losses in the barn had been nearly as much as in the stack. A study of the amounts of dry matter shows that these losses are almost entirely losses in weight of water. The hay as put in the barn contained 20.8 per cent of water; when taken out it contained but 12.1 per cent of water. There were 13,804 pounds of dry matter put into the barn and 13,478 pounds of dry matter taken out, being a loss of but 2.5 per cent. Since there was no waste hay this 2.5 per cent represents also the loss in feeding value in the barn.

The final averages show 12.4 per cent of feeding value lost in the stack, while but 2.5 per cent of feeding value was lost from the hay that was put in the barn. This shows a difference of ten per cent in favor of the barn.

In other words *nine tons of hay put in the barn will feed as much stock as ten tons put in the stack.*

It should be remembered that while these results indicate average conditions for the barn, they represent rather better than average figures for stacks of the first cutting of alfalfa in Northern Colorado. The stack under experiment was put up in good shape and had a chance to settle well before much rain fell upon it, while the season was in general favorable for hay in stack. These figures may be said to represent the least losses that one should expect with the first cutting. Had the same test been made in 1895 a very different story would result. That year at least one-third of the dry matter in the stack was lost. We made an extended test of the feeding value of this injured stack hay as compared with similar hay from the barn. It was found that the sheep eating the two lots of hay made exactly the same gain for the entire five months of the test, but for every two tons of hay from the barn we had to draw three tons from the stack, and this was in addition to the large amounts of worthless hay on the tops and bottoms of the stack. In that year therefore 4.4 tons of hay put into the barn yielded as much feed as 10 tons in the stack.

Of course this is an extreme case, but the average loss of all years for Northern Colorado is probably not less than a

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fifth, that is, eight tons of hay in the barn is equal to ten tons of hay in the stack.

It may be asked why the farmers do not build barns for their hay and save these large losses. The answer is easily given. Barns are expensive to build and keep in repair; the labor of putting hay into the barn and feeding it to any stock, except milch cows, is considerably more than to handle the hay by stacking. At present low prices of hay, the two items above more than equal the losses of hay in the stack. It seems probable that at six dollars a ton the gains will about equal the losses, and at above that price one could not afford to stack the first cutting.

All the above calculations are for the first cutting and for Northern Colorado. The losses with the second cutting are much less, while the the third cutting has practically no loss.

C—ALFALFA ENSILAGE.

Some tests were carefully made on a small scale to see what losses might be expected in making ensilage of alfalfa. One test was made with the alfalfa put in whole as cut in the field, the other with the alfalfa cut to quarter inch pieces as we cut our corn for ensilage. The whole alfalfa showed a spoiled layer three inches thick on the top and an inch layer around the side nearly all the way down. The ensilage of the bottom and middle was excellent and was greedily eaten by the cows and calves. Its loss in the total weight was 10.7 per cent, but its loss in feeding value was probably a little larger.

The other silo was filled with cut alfalfa. The next day the silo was covered with two thicknesses of building paper and one of boards and weighted with stone to about fifty-five pounds per square foot. When coverd the ensilage was hotter than the hand could bear. Two days later the temperature had fallen to 83° F. and in two days more it had fallen to that of the air. The ensilage shrank and settled a good deal. When put in it contained 33.0 per cent of dry matter. On opening the silo showed two inches of spoiled ensilage on top and half an inch on the sides. The spoiled ensilage was 7.3 per cent of the total weight. The loss in dry matter was approximately ten per cent.

It is fair to presume that with a good tight silo, well made ensilage from cut alfalfa should not make a larger loss than was here given in our small experimental silo, or about ten per cent of its feeding value. To make good

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ensilage from whole alfalfa is a much harder proposition. It requires that the alfalfa be quite green; that the silo be both tight and deep; that the alfalfa be thrown into the silo in small forkfuls and carefully tramped and that it be weighted by four to six feet of some heavy, tight packing material like cut corn fodder. If the alfala is put up in the middle of summer in clear, bright weather, it must be raked and loaded as fast as cut. One lot we tried was too dry for ensilage two hours after it was cut.

D—THREE METHODS OF HANDLING ALFALFA.

The preceding pages have given the losses that may be expected from handling alfalfa in the stack, in the barn and in the form of ensilage. Combining the losses in curing and gathering to those found in the stack and the barn, we can say that under the best of ordinary conditions, for every 100 pounds of feeding value as it exists in the green alfalfa at the time it is cut by the mower, 77 pounds will be saved if the hay is well cured and put in a stack under good conditions; 86 pounds will be saved if put in the barn, and 90 pounds can be expected if made into first-class ensilage. The cost of the ensilage is so much more than handling the alfalfa as hay that as between the silo and the barn there can be no question unless it is shown that the dry matter of the alfalfa ensilage has a higher feeding value, pound for pound, than that of the dry hay. In the comparison of the ensilage and the stacked hay, the principal advantage of the ensilage must lie in the fact that the alfalfa can be put in the silo, even under bad conditions of weather at time of cutting, and that once siloed it is safe from the worst weather.

E—TOP-DRESSING ALFALFA.

A field which had been in alfalfa three years was divided into five equal plots. The first, third and fifth were left as checks. The second plot was fertilized at the rate of sixty loads to the acre of fine, well rotted sheep manure. The fourth plot received half as heavy a top-dressing. The manure was spread on in the winter and after the alfalfa started in the spring, it was run over with a smoothing harrow to break up the manure fine and allow the alfalfa shoots a good chance to grow.

When the field was ready for the first cutting the eye

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could detect a difference between the plots. Those which had been manured were a darker green, the stems were larger, taller and more succulent, but they did not seem to be so numerous as on the untreated plots. The whole field was cut the same day and the hay on each plot was hauled the same day.

FIRST CUTTING.

Plot.	Weight of hay.	Per cent of dry matter.	Weight of dry matter per plot.
1	3100	88.7	2750
2	3212	81.3	2611
3	3080	88.9	2738
4	3112	88.5	2764
5	3172	89.3	2838
Average 1, 3, 5	3117	88.9	2771
Average 2, 4,	3162	84.9	2685

SECOND CUTTING.

1	1978	81.9	1609
2	2518	79.8	2009
3	1720	82.8	1424
4	1920	81.0	1555
5	1842	78.9	1453
Average 1, 3, 5	1847	81.2	1500
Average 2, 4,			

THIRD CUTTING.

1	1100	83.2	915
2	1340	85.9	1151
3	970	88.7	860
4	1010	88.5	894
5	890	86.2	767
Average 1, 3, 5	987	86.0	849
Average 2, 4,	1175	86.0	1010

TOTAL CROP FOR THE YEAR.

1	6178	85.4	5274
2	7070	81.3	5771
3	5770	87.0	5022
4	6042	86.3	5213
5	5884	85.9	5058
Average 1, 3, 5	5944	86.1	5118
Average 2, 4,	6556	83.8	5492
Difference in favor of fertilizing	612		374
Percentage Difference	10.3		7.3

CROP FOR THE SECOND YEAR.

Plot.	First Cutting.	Second Cutting.	Third Cutting.	Total Crop.
1	2240	1900	1240	5380
2	2490	1908	1394	5792
3	2000	1546	1158	4704
4	2170	1856	1458	5484
5	2170	1820	1458	5448
Average 1, 3, 5	2137	1755	1285	5177
Average 2, 4,	2330	1882	1426	5638
Difference in favor of fertilizing				461
Percentage difference				8.9

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In both years the application of the fertilizer has apparently had a beneficial effect, but the result is not at all commensurate to the expense. Considering the manure itself as having no value, the mere hauling and spreading on the ground cost at the rate of more than thirty dollars per acre. The plots were close to an acre in size, so that the figures indicate a gain of about 500 pounds of hay or, at present prices, about a dollar's worth per acre.

No one could afford to top-dress alfalfa with the prospect of gaining only a dollar per acre per year. It seems probable that if it is desired to fertilize the land for alfalfa, that the land be plowed, the manure being turned to the bottom of the furrow, then the land cropped with corn and grain for one or two years and then seeded to alfalfa. We undertook to make this test, but the experiment was never completed.

In order to ascertain whether this heavy supply of plant food had made any difference in the chemical composition of the alfalfa, samples were analyzed of each of the cuttings of both the fertilized and unfertilized plots.

COMPOSITION OF DRY MATTER.

Cutting	Ash	Ether Extract	Crude Protein	Crude Fiber	Nitro-g'n-free Extract	Total Nitrg'n	Phos-phoric Acid	Potash
First, fertilized	11.29	1.54	13.88	35.74	37.55	2.22	0.59	3.09
Unfertilized	9.71	1.34	13.14	39.59	36.23	1.98	0.46	3.29
Second, fertilized	9.12	1.02	11.14	43.63	35.09	1.78	0.43	3.12
Unfertilized	8.95	1.04	11.08	45.22	33.71	1.78	0.36	2.31
Third, fertilized	10.99	1.19	14.58	36.74	36.51	2.33	0.47	2.75
Unfertilized	10.64	1.24	14.59	36.75	36.78	2.33	0.42	2.91
Average fertilized	10.47	1.25	13.20	38.70	36.38	2.11	0.51	2.99
Average unfertilized	9.77	1.21	12.97	40.52	35.59	2.03	0.41	2.83

The third cuttings are essentially duplicates. In the first and second cuttings the alfalfa from the fertilized plots has a higher feeding value and is richer in plant food. These differences are large enough so as to make it probable that the results are not accidental, but are due to real differences of composition caused by the application of the fertilizer.

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F—MOISTURE IN GREEN ALFALFA.

The actual amount of water in alfalfa at the moment the mower knife cuts it, we have tested but little, as this has hardly any practical bearing, but we have made several tests of how much moisture it holds about an hour later, that is, in the condition it would be if put in the silo. One test the last week in May gave 76.8 per cent of water, or 23.2 per cent of dry matter. Four tests the third week in June gave 69.7, 67.0, 75.6, 72.8 with an average of 71.3 per cent of water, which is just about right for the best results in the silo.

A sample cut in September, in bright drying weather, was dried to 62.0 per cent water in an hour, too dry to be put in the silo, while a sample as actually put in the silo in October during cloudy weather was 74.0 per cent water.

G—MOISTURE IN ALFALFA HAY.

Few farmers realize how much water there is in what they call dry hay.

It is impossible to dry out all the water from hay without resorting to artificial heat. Hay spread out in a thin layer in direct sunlight and sheltered from all rain and dew will finally dry out until a hundred pounds of hay contains only five pounds of water. This is as dry as it can be gotten without the use of a regular drying oven.

In Colorado "air dry" means with about ten per cent of water; that is, if hay is stored in a barn and sweats and drys out thoroughly, a hundred pounds will contain about ten pounds of water. Oats and wheat in the bin late in the winter contain about the same amount of water, while corn in the crib will contain by the next spring about the same ten per cent of water.

But the "well cured" hay, as usually put in the stack or the barn, is far from these conditions. In the course of our experiments we have had occasion to test the moisture of thirty-five samples of hay taken in different years and representing the three cuttings.

Three samples taken in June tested 23.2, 30.0 and 26.3 per cent of water, with an average of 26.5 per cent and they heated quite badly, becoming dusty and a little darkened. Seventeen samples that kept well tested 14.0, 13.0, 9.3, 11.2, 20.6, 22.7, 22.9, 17.1, 19.4, 17.8, 15.2, 23.1, 11.0, 10.8, 10.4, 18.4, 11.7 per cent with an average of 15.2 per cent of water. The dryest of these with 9.3 per cent of water is too dry,

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being so brittle as to lose too much in handling, while the wetter ones 20.0 per cent and above will probably contain some forkfuls that are too wet and will make the hay dusty. From 15 to 18 per cent of water is about right for the proper handling of the hay and its settling in the stack so as to shed rain. This means that the hay will lose about one-fourteenth of its weight of water in drying out in the stack, besides its loss from fermentation and washing.

The samples of hay from the second cutting contained 22.0, 24.0 and 24.0 per cent water and heated somewhat. Five samples contained 16.8, 18.9, 15.9, 17.7, 19.8 with an average of 17.8 per cent of water and all kept well.

Five samples of hay from the third cutting tested 15.5, 13.3, 11.0, 11.2, 13.5 averaging 1.30 per cent of water and all kept in excellent shape.

II. CORN.

A—SILO NOTES.

The very cheaply built silo described in a former bulletin of this station was filled with fodder corn. In one of the four compartments the top layer was composed of about a ton of corn, and the covering consisted of a layer of wet straw and then about four inches of wet dirt. The top layer was spoiled for a little over two inches. This and the covering make a weight for the second layer of about sixty pounds per square foot. This second layer contained 9997 pounds of corn fodder at the time of filling. When opened and fed out the last of December it weighed just a thousand pounds less, or a loss of ten per cent. The layer next under this shrank from 9721 pounds put in, to 9409 pounds taken out—a loss of but three per cent. The most expensive silo could not preserve corn with a less loss.

When the silo was filled the corn was separated into four layers by boards, and rods of known lengths were firmly attached to these board partitions, so that as the boards settled the thickness of the layers would be known from the height of the rods.

The silo was ten feet square and the bottom layer contained 6588 pounds of fodder corn cut into quarter inch pieces. When on top of this layer one more load had been

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placed and well tramped, that is, half an hour later with a weight of fifteen pounds to the square inch, the layer was 34½ inches thick, giving a weight of 23 pounds to the cubic foot. In another hour, with a weight on top of 95 pounds to the square foot, the layer had been squeezed five inches thinner and weighed 27 pounds to the cubic foot. The next morning with an average pressure of about 213 pounds to the square foot, the layer weighed 31 pounds to the cubic foot. During the next two days the silo was filled up, covered with wet straw, allowed to stand four days and then covered with wet dirt. This gave an average pressure of 323 pounds to the square foot. Three days later, that is ten days after the corn was put in the silo, the bottom layer had settled 7 inches to 18½ inches thick, or 44 pounds to the cubic foot. Six weeks later it had settled two inches more and another inch in the next month. It then weighed 50.7 pounds to the cubic foot. When the pressure was removed by the throwing out of the upper layers, this bottom layer expanded one inch from 15½ to 16½ inches, or from 50.7 pounds to the cubic foot to 47.9 pounds.

The next to the bottom layer contained 9721 pounds of fodder corn. An hour after it was put in the silo, when it was weighted 35 pounds to the square foot, it made a layer 58 inches thick, or 20 pounds to the cubic foot. By the next day at noon, with 125 pounds of weight to the square foot, the layer had been reduced to 48 inches thick or 24 pounds to the cubic foot. At the end of eight days, with an average pressure of 244 pounds per square foot, it had shrunk a quarter more and weighed 31 pounds to the cubic foot. Ten weeks later, when the bottom layer weighed 50.7 pounds to the cubic foot, this layer weighed but 33.3 pounds. One had a pressure of 244 pounds and the other 323 pounds per square foot and the one with the lighter pressure is the heavier proportional to the pressure.

The third layer from the bottom contained 9997 pounds fodder corn. An hour after it was put in, with a pressure of 25 pounds per square foot, it was 57 inches thick or 21 pounds to the cubic foot. Eight days later, with an average pressure of 145 pounds per square foot, the layer was 39.5 inches thick, 30.3 pounds per cubic foot. Here, again, the weight per cubic foot is not proportional to the pressure. It did not change from this weight, compressing only to 31.5 pounds per cubic foot at the lowest. When the cover and upper layer were removed the top of this third layer rose two and a half inches, this being the amount that the whole mass of the three layers below expanded. This expansion seemed to be one inch for the first and third layers and half

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an inch for the middle layer. As the three layers together were 88 inches thick, the expansion was but three per cent when a weight of 95 pounds per square foot was removed.

The three layers together were 88 inches thick and averaged 36 pounds per cubic foot with a pressure above 95 pounds per square foot, or an average pressure for the whole of 226 pounds per square foot. It has been estimated that it requires a pressure of about 1500 pounds per square foot or about ten pounds to the square inch to compress ensilage to its least possible bulk, when it will weigh nearly 64 pounds to the cubic foot. This is on supposition that the fodder corn is properly matured. The greener the corn the more it will weigh to the cubic foot with small pressures and the less pressure it will take to force out the last of the air.

B—SEED CORN FROM DIFFERENT ALTITUDES AND LATITUDES.

A test was made extending over four years to see whether the altitude or latitude of the place at which the seed was grown would have any effect on the yield when planted in Colorado. Or, to put the problem in a little different words, to see whether Colorado grown seed was better or poorer than that grown further east. The two varieties, Pride of the North and Leaming, were selected for the test since they are the largest corn that will ripen at Fort Collins, and the seed is handled by most of the large seed dealers. Fort Collins is out of the main corn belt so that none of the yields are so high per acre as are commonly obtained in the Mississippi Valley, nor nearly so large as would be grown in the Arkansas Valley in this State. But the principle of comparison is the same, even with the smaller yields. The following tables give the weight per acre of the whole crop or what it would yield if grown for ensilage and also the weight per acre of shelled corn.

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WEIGHT OF WHOLE CROP PER ACRE.

Pride of the North.

State	Firm	1895 lbs.	1897 lbs.	1898 lbs.	1899 lbs.	Aver'ge lbs.
Nebraska	Nebraska Seed Co	14250				14250
Colorado	Lee-Kinsey	18500	16000	6375	12666	13385
"	Barteldes & Co	14875		8000	14833	12569
Pennsylvania	W. H. Maule	20625				20625
Illinois	Vaughn Seed Store	18875				18875
Colorado	Matthews	16750				16750
Iowa	Iowa Seed Co		17500	6625	6538	10221
Minnesota	Northrop King & Co		10066	3250	7142	7019
Illinois	J. Bauscher		14416	10500	7802	10839
Minnesota	L. L. May Co		13500	6500	12934	10978
Pennsylvania	W. A. Burpee		10833	6000	8111	8314
Ohio	Storrs Harrison & Co		12416	5875	9818	9369
New York	J. M. Thorburn		21750	10000	15522	15757
Illinois	H. W. Buckbee		11083	3125	7659	7289
Michigan	D. M. Ferry		3250	6125	8653	6009

WEIGHT OF SHELLED CORN PER ACRE.

Pride of the North.

State	Firm	1897 lbs.	1898 lbs.	1899 lbs.	Aver'ge lbs
Iowa	Iowa Seed Co	2000	900	1730	1543
Minnesota	Northrop King & Co	1833	652	2261	1582
Colorado	Lee-Kinsey	1000	795	2666	1487
Illinois	J. Bauscher	1333	1656	2142	1710
Minnesota	L. L. May Co	1416	840	2375	1543
Pennsylvania	W. A. Burpee	1250	997	2000	1415
Ohio	Storrs Harrison & Co	750	787	2000	1179
New York	J. M. Thorburn	2166	785	2587	1812
Illinois	H. W. Buckbee	1583	850	2123	1520
Michigan	D. M. Ferry	166	1087	2596	1283
Colorado	Barteldes & Co		840	2166	1503

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WEIGHT OF WHOLE CROP PER ACRE.

Leaming.

State	Firm	1895 lbs.	1897 lbs.	1898 lbs.	1899 lbs	Aver'ge lbs.
Nebraska	Nebraska Seed Co	19250	.....	.....	.....	19250
Pennsylvania	D. Landreth	18500	18416	.....	13500	16805
"	W. H. Maule	20875	14833	7500	17900	15277
Illinois	Vaughn Seed Store	17000	.....	.....	.....	17000
Iowa	Iowa Seed Co	.....	20250	11000	15319	15523
Minnesota	Northrop King & Co	19625	21083	6750	10769	14566
California	Cox Seed Co	.....	26833	6000	14318	13717
Colorado	Barteldes & Co	15125	27750	10000	6018	14723
Massachusetts	R. & J. Farquhar	.....	23250	.....	13205	18228
Minnesota	L. L. May Co	.....	24833	8250	15925	16336
Wisconsin	J. A. Salzer	.....	24833	9375	13921	15876
Pennsylvania	W. A. Burpee	.....	20166	2875	13571	12204
Ohio	Storrs Harrison & Co	.....	20166	8000	15106	14424
New York	J. M. Thorburn	.....	17333	4875	12708	11638
Illinois	H. W. Buckbee	.....	22000	6875	14411	14428
Massachusetts	J. J. H. Gregory	.....	25416	10250	13921	16529
Pennsylvania	Johnson Stokes & Co	.....	14750	4000	14857	11202

WEIGHT OF SHELLED CORN PER ACRE.

Leaming.

State	Firm	1897 lbs.	1898 lbs.	1899 lbs.	Aver'ge lbs.
Iowa	Iowa Seed Co	1750	1182	2659	1864
Minnesota	Northrop King & Co	2250	945	2892	1962
California	Cox Seed Co	2000	575	2613	1729
Colorado	Barteldes & Co	1666	340	1481	1296
Massachusetts	R. & J. Farquhar	2083	.....	1923	2003
Pennsylvania	D. Landreth	1750	.....	1800	1775
Minnesota	L. L. May Co	2000	822	2692	1838
Wisconsin	J. A. Salzer	2083	537	1764	1461
Pennsylvania	W. A. Burpee	1750	.....	1982	1866
"	W. H. Maule	666	472	3000	1379
Ohio	Storrs Harrison & Co	1166	591	2021	1259
New York	J. M. Thorburn	2000	505	1458	1321
Illinois	H. W. Buckbee	2083	577	2745	1801
Massachusetts	J. J. H. Gregory	2750	618	2058	1809
Pennsylvania	Johnson Stokes & Co	1416	410	2142	1323

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The results are not at all uniform, but it seems possible to draw the conclusions that the seed grown in Colorado produces just about the average of that grown in all the other states for Pride of the North, and less than the average for the Leaming. The northern grown seed shows poorly for Pride of the North and among the best for the Leaming. The eastern grown seed Massachusetts, Pennsylvania and New York on the whole gives better returns than that grown west of the Mississippi river.

C—VARIETY TESTS OF CORN.

For the past six years there have a large number of the principal varieties of corn been grown on the college farm. It is believed that the results of so long a test will prove valuable as giving a clear indication of the general kind and size of corn that will do the best under the given conditions of altitude and latitude. All grades were tested, from the Will's Gehu that ripens long before frost and bears its ears less than a foot from the ground, to the Giant Mexican June that sends out its silk as high as a man can reach and is barely tasseling at the usual harvest time.

In all cases the corn was planted in hills three feet apart each way. In 1895 it was not irrigated and the crop was small. The other years the corn was irrigated twice. The land on which this corn was grown was a different field each year and was for the most part on ground that had been heavily manured. In all cases it was land so rich and in such condition that it would have raised a large crop of grain. In other words the small crops are due to the climate rather than the soil, and show that Fort Collins is outside of the corn belt. Still, corn will grow here so well that if it was not for the ease and cheapness with which alfalfa can be grown, corn would be the cheapest fodder for dairy stock.

VARIETY TESTS OF CORN 1894.

Variety.	Total Crop per acre.	Green Ears per acre.	Green Stover per acre.	Shelled Corn per acre.
Flint Corn—				
Golden Dew Drop..	16,800	4,820	11,980	1,926
Will's Gehu	14,200	4,900	9,300	2,117
King Philip.....	19,200	3,600	15,200	1,028
Sanford	23,400	5,300	18,100	1,809
Longfellow	19,600	3,850	15,750	1,327
Minn. King.....	14,200	2,900	11,300	1,176
Dent Corn—				
Queen of the Field..	22,800	6,300	16,500	1,686
Huron.....	18,400	5,423	12,977	2,408
White Pearl	21,400	6,869	14,531	2,408

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Variety.	Total Crop per acre.	Green Ears per acre.	Green Stover per acre.	Shelled Corn per acre.
Wis. Yellow Dent...	21,600	5,900	15,700	2.167
Pride of the North..	24,800	5,800	19,000	1,809
Cali. Yellow.....	22,400	6,250	16,150	1,926
Mastodon.....	25,000			
Chester County Mam.	21,200			
Red Cob.....	23,200			
Champ. Co. Prolific..	23,000			
Leaming.....	30,800			
Giant Fodder	35,000			
Va. Mammoth.....	20,800			

VARIETY TESTS OF CORN 1895.

Flint Corn—				
Golden Dew Drop...	12,100	2,600	9,500	
Will's Gehu	7,875	3,750	4,125	
King Philip.....	13,000	3,100	9,900	
Sanford	14,750	4,375	10,375	
Longfellow.....	14,200	2,000	12,200	
Minn. King	13,000	3,900	9,100	
White Australian ...	18,600	6,500	12,100	
Angel of Midnight..	12,600	2,000	10,600	
Yellow Australian ..	10,700	4,700	6,000	
Colorado White.....	25,100	4,400	20,700	
Brazilian Flour	18,000	....	18,000	
Dent Corn—				
King of the Earliest.	20,400	3,900	16,500	
Queen of the Field..	18,500	5,500	13,000	
Huron.....	12,100	3,800	8,300	
White Pearl	14,700	1,900	12,800	
Pride of the North..	17,500	4,000	13,500	
Gold Mine.....	18,000	4,500	13,500	
White Cap Dent....	17,000	2,300	14,700	
Grafflin.....	15,700	4,000	11,700	
Riley's Favorite.....	19,000	2,700	16,300	
Mastodon.....	15,250	1,751	13,500	
Red Cob.....	20,000	....	20,000	
Leaming.....	18,400	3,750	14,650	
Giant White Dent...	18,400	2,200	16,200	
Conqueror.....	7,000	900	6,100	
Mam. Cuban.....	20,400	4,400	16,000	
Mam. Red	20,500	4,500	16,000	
Giant Mex. June....	13,600	....	13,600	
Swadley	11,100	4,900	6,200	
Golden Row	20,700	2,700	18,000	
Golden Beauty.....	22,200	3,700	18,500	
Nebr. White Prize ..	17,400	3,200	14,200	
Early California .. .	21,000	4,000	17,000	
Golden Seal	23,700	5,200	18,500	
Hathaway's Yel. Dent	18,700	8,500	10,200	
Evergreen Sweet....	15,600	3,400	12,200	

VARIETY TESTS OF CORN 1896.

Flint Corn—				
Golden Dew Drop..	24,500	3,750	21,750	1,670
Will's Gehu.....	9,300	4,100	5,200	2,330
King Philip.....	19,250	3,830	15,420	1,900
Sanford	24,100	4,500	19,600	1,417
Longfellow	25,800	2,580	23,220	1,090
White Australian...	19,500	6,100	13,400	3,000
Angel of Midnight..	16,100	1,600	14,500	400
Yellow Australian...	6,800	2,300	4,500	1,100
Colorado White.....	27,600	4,700	22,900	1,400

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Variety.	Total Crop per acre.	Green Ears per acre.	Green Stover per acre.	Shelled Corn per acre.
Brazilian Flour.....	44,500	....	44,500	....
Dent Corn—				
Queen of the Field..	22,200	6,250	15,950	2,750
White Pearl.....	20,500	2,700	17,800	500
Pride o the North..	19,700	4,600	15,100	2,250
Dakota Dent.....	16,000	4,000	12,000	1,900
Gold Mine.....	17,500	4,800	12,700	....
White Cap Dent....	24,700	4,900	19,800	....
Grafflin.....	17,800	4,000	13,800	1,600
Riley's Favorite.....	20,300	2,700	17,600	....
Mastodon.....	18,200	3,250	14,950	1,000
Red Cob.....	33,200	3,900	29,300	....
Leaming	18,700	4,400	14,300	2,400
Giant White Dent..	16,600	1,600	15,000	250
Conquerer.....	14,400	1,600	12,800	....
Mam. Cuban.....	21,100	5,200	15,900	1,900
Mam. Red.....	19,000	3,200	15,800	....
Giant Mex. June....	84,000	....	84,000	....
Swadley	10,800	3,800	7,000	2,000
Golden Row.....	31,000	5,700	25,300	1,900
Golden Beauty.....	27,200	5,300	21,900	....
Neb. White Prize...	22,700	3,100	19,600	750
Early California	24,100	3,700	20,400	....
Golden Seal.....	13,200	3,400	9,800	1,300
Hathaway's Yellow Dent.....	18,100	6,100	12,000	....
Evergreen Sweet....	20,700	1,700	19,000	500

VARIETY TESTS OF CORN 1897.

Flint Corn—				
Sanford	13,750	2,667	11,083	1,250
Longfellow	16,861	2,917	13,944	1,139
White Australian...	15,583	4,333	11,250	2,250
Angel of Midnight..	16,000	4,083	11,917	1,750
Squaw Corn.....	7,167	3,000	4,167	2,083
Compton's Early....	17,250	2,917	14,333	1,417
Earliest Ripe.....	4,416	2,083	2,333	1,250
Early Canada.....	12,666	2,833	9,833	1,333
Minn. White Flint..	17,666	4,583	13,083	2,250
Red-blazed	9,750	1,500	8,250	750
Pride of Canada....	13,000	2,250	10,750	1,167
Brazilian Flour.....	21,500	....	21,500	....
White Flint.....	14,583	3,250	11,343	1,167
Dent Corn—				
Pride of the North..	14,242	3,371	10,871	1,568
Dakota Dent.....	8,666	3,083	5,583	1,416
Huron.....	17,333	3,583	13,750	1,833
Gold Mine.....	17,333	3,250	14,083	1,417
Grafflin.....	12,333	2,333	1,000	2,000
King of the Earliest,	20,083	3,667	16,416	1,667
Iowa Silver Mine....	18,667	3,167	15,500	1,167
Red Cob.....	40,333	7,583	32,750	2,333
Leaming.....	21,028	4,589	16,439	1,761
Cuban Giant.....	17,333	1,917	15,417	500
Giant Mex. June....	44,417	.....	44,417	.....
Swadley	12,500	3,250	8,250	1,583
Golden Beauty.....	20,875	3,792	17,083	1,209
Evergreen Sweet....	20,667	3,000	17,667	750
Blount's Mammoth.	25,167	4,500	20,667	1,250

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VARIETY TESTS OF CORN, 1898.

Variety.	Total Crop per acre.	Green Ears per acre.	Green Stover per acre.	Shelled Corn per acre.
Flint Corn—				
Sanford	7,125	1,125	6,000	
Longfellow	6,708	1,333	5,375	
Angel of Midnight	8,500	1,500	7,000	
Squaw Corn	5,375	3,250	2,125	
Compton's Early	7,500	1,250	6,250	
Early Red Blazed	6,750	1,500	5,250	
Pride of Canada	10,625	2,000	8,625	
Dent Corn—				
Pride of the North	6,438	1,750	4,688	930
Dakota Dent	3,125	1,500	1,625	
Early Huron	5,625	1,750	3,875	
Gold Mine	8,625	2,375	6,250	
Grafflin	5,875	2,250	3,625	
King of the Earliest	8,125	1,375	6,750	
Silver Mine	11,875	2,250	9,625	
Red Cob	12,125	375	11,755	
Leaming	7,365	1,448	5,917	642
Cuban Giant	8,375	750	7,625	
Giant Mexican	9,750	....	.....	
Evergreen	4,500	500	4,000	
Blount's Mammoth	5,875	....	.....	

VARIETY TESTS OF CORN, AVERAGE OF 1894-1898.

Flint Corn—				
Golden Dew Drop	17,800	3,723	14,808	1,798
Will's Gehu	10,458	4,250	6,208	2,857
King Philip	17,150	3,510	13,640	1,464
Sanford	16,625	3,593	13,032	1,492
Longfellow	16,634	2,536	14,098	1,185
Minn. King	13,600	3,400	10,200	1,176
White Australian	17,894	5,644	12,250	2,625
Angel of Midnight	13,400	2,296	11,104	1,025
Yellow Australian	8,750	3,500	5,250	1,100
Colorado White	26,350	4,550	21,800	1,400
Brazilian Flour	28,000	.....	28,000	.....
Squaw Corn	6,271	3,125	3,146	2,083
Compton's Early	12,375	2,084	10,291	1,417
Earliest Ripe	4,416	2,083	2,333	1,250
Early Canada	12,666	2,833	9,833	1,333
Minn. White Flint	17,666	4,583	13,083	2,250
Red-blazed	8,250	1,500	6,750	750
Pride of Canada	11,813	2,125	9,688	1,167
White Flint	14,583	3,250	11,333	1,167
Dent Corn—				
Queen of the Field	21,167	6,017	15,150	2,218
Huron	14,115	3,639	10,476	2,121
White Pearl	18,867	3,823	15,044	1,954
Wis. Yellow Dent	21,600	5,900	15,700	2,167
Pride of the North	16,536	3,904	12,632	1,639
Cal. Yellow	22,400	6,250	16,150	1,926
Mastodon	19,483	2,500	16,983	1,000
Chester Co. Mam	21,200	.....	.....	.....
Red Cob	25,772	3,953	21,819	2,333
Champ Co. Prolific	23,000	.....	.....	.....
Leaming	19,259	3,547	15,712	1,601
Giant Fodder	35,000	.....	.....	....
Va. Mammoth	20,800	.....	.....	.....
King of the Earliest	16,203	2,981	14,222	1,667
Gold Mine	15,365	3,731	11,634	1,417
White Cap Dent	20,850	3,600	17,250	.....

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Variety.	Total Crop per acre.	Green Ears per acre.	Green Stover per acre.	Shelled Corn per acre.
Grafflin	12,927	3,146	9,781	1,800
Riley's Favorite	19,650	2,700	16,850	.....
Giant White Dent	17,500	1,900	15,600	250
Conqueror	10,700	1,250	9,450	.....
Mam. Cuban	20,750	4,800	15,950	1,900
Mammoth Red	19,750	3,850	15,900	.....
Giant Mex. June	37,942	.....	37,942	.....
Swadley	11,467	3,983	7,484	1,792
Golden Row	25,850	4,200	21,650	1,900
Golden Beauty	23,425	4,264	19,161	1,209
Neb. White Prize	20,050	3,150	16,900	750
Early California	22,550	3,850	18,700	.....
Golden Seal	18,450	4,300	14,150	1,300
Hathaway's Yellow Dent	18,400	7,300	11,100	.....
Evergreen Sweet	15,367	2,150	13,217	625
Dakota Dent	9,264	2,861	6,403	1,658
Iowa Silver Mine	15,271	2,709	12,562	1,167
Cuban Giant	12,854	1,334	11,520	500
Blount's Mammoth	15,021	4,500	10,521	1,250

D—NUMBER OF STALKS IN A HILL.

The effect on the yield of the corn, of a different number of stalks in a hill, was noted two different years. The first year the crop was rather larger than an average crop in this part of Colorado. The number of stalks in each hill was counted and the weight of each hill recorded. Omitting the outside rows leaves 320 hills, which were divided as follows:

No. of Stalks Per Hill	No. of Hills containing this No. of Stalks	Per Cent of Total No. of Hills	Total Weight	Average Weight Per Hill	Average Weight Per Stalk
0	76	24	0	0	0
1	22	7	60	2.7	2.7
2	30	9	133	4.4	2.2
3	52	16	284	5.5	1.8
4	56	17	397	7.1	1.8
5	47	15	375	8.0	1.6
6	29	9	260	9.0	1.5
7	6	2	53	9.0	1.3
8	1	0	11	11.0	1.4
Av. and Total..8	320	100	1513	4.7	1.6
Omitting missing hills.....4	244		1513	6.2	1.6

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It will be noted that as the number of stalks in a hill increases, the size of each stalk diminishes, but the increase in number much more than overbalances the decrease in size and the weight of the hill is greater the larger the number of stalks. A hill containing six stalks weighs much more than a hill of one stalk, but instead of weighing six times as much, it weighs a little more than three times as much.

The same principle is seen the second year when a larger number of hills was weighed from a field having rather less than an average crop in size.

No. of Stalks Per Hill	No. of Hills containing this No. of Stalks	Per Cent of Total No. of Hills	Total Weight	Average Weight Per Hill	Average Weight Per Stalk
0	107	14	0	0	0
1	58	7	97	1.7	1.70
2	130	16	339	3	1.50
3	271	35	1053	3.9	1.30
4	162	21	687	4.2	1.05
5	46	6	243	5.3	1.06
6	10	1	62	6.3	1.05
Average and Total,	784	100	2533	3.5	1.22
Omitting missing hills	677	86	2533	4.1	1.22

There is no indication in the figures of either year as given in this form that the increase could not go on indefinitely. The larger the number of stalks the larger the weight of the hill seems to be the rule. But there really is a limit. If each hill was by itself with plenty of space on all sides, the above rule would be true. When, however, the hills are only three feet apart, as was the case in these fields, there is room for only a certain number of stalks to grow and develop on a given area. The addition of one more plant to a hill not only decreases the size of the other plants in that hill, but it also decreases the size of each of the four hills surrounding it. If these several losses amount to more than the weight of the extra plant, then its presence in the field is a positive loss. For each field there is such a point and when that point is reached is the number of stalks per hill that gives the largest yield of crop per acre. To learn what this number is, the number of stalks in the four hills next to each hill was then counted and the weight of the hill recorded. Combining these data and interpolating to get even numbers, gives the results below;

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No. of stalks in a hill.	Average No. of stalks in the 4 hills about it.	Weight of the hill lbs.	Weight per acre tons.
1	1	3.5	8.7
	3	2.6	6.2
2	2	4.6	11.5
	3	4.5	11.2
3	3	5.4	13.5
	4	4.6	10.5
4	3	6.8	17.0
	4	6.2	15.5
	5	5.9	14.7
5	3	8.0	20.0
	4	8.0	20.0
	5	7.6	19.0
6	5	7.3	18.2
	6	7.0	17.5

From the last table we can estimate the yield per acre from the different number of stalks in a hill:

6 stalks per hill give a crop of 17.5 tons per acre
5 " " " " 19.0 " "
4 " " " " 15.5 " "
3 " " " " 13.5 " "
2 " " " " 11.5 " "
1 " " " " 8.7 " "
Half 4 stalks and half 5 stalks 17.0 " "

If the hills are equally divided among the different numbers from one to six, the resulting crop would be about 14.0 tons per acre.

These figures show that in this field the largest crop would be obtained from five stalks in each hill. If a hill contained six stalks, with five stalks in each hill surrounding it, the extra stalk caused a net loss of about a third of a pound per hill, showing but slight loss, while if it contained four stalks, or one less than the best number, the net loss was 1.7 pounds per hill.

The next year shows some unexpected figures. It had been supposed that with a lighter crop of smaller stalks, the field would support a greater number of stalks, but the figures do not seem to warrant this conclusion.

No. of stalks in a hill.	Average No. of stalks in the 4 hills around it.	Weight of the hill lbs.	Weight per acre tons.
1	1	2.12	5.3
	3	1.57	3.9
2	2	3.31	8.3
	3	2.80	7.0
3	3	3.94	9.8
	4	3.45	8.6
4	3	4.66	11.6
	4	4.57	11.4
	5	4.21	10.5
5	3	5.01	12.5
	4	4.52	11.3
	5	3.87	9.7

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It is evident here that the largest crop is one that has four stalks in each hill, since the weights with the different numbers of stalks give:

5	stalks	per	hill	give	a crop of	9.7	tons per acre
4	"	"	"	"		11.4	" "
3	"	"	"	"		9.8	" "
2	"	"	"	"		8.3	" "
1	"	"	"	"		5.3	" "

Since this field gives a smaller crop per acre from smaller stalks, and yet gives a larger return from four stalks in a hill than from five stalks, it cannot be said that it is always better to have less stalks in a hill, the larger the variety of corn.

Since these two crops represent a good share of the crops of northern Colorado, it can be said that where corn is raised for fodder four or five stalks in a hill, if the hills are three feet apart each way, gives the largest crop per acre.

E—MISSING HILLS IN A CORN FIELD.

One of the largest sources of loss in the cornfield is hills without any stalks. In the field of corn grown the first year, it was thought that there were not enough hills missing to pay for replanting, but when harvest came, the count showed 24 per cent missing or a loss in this field of about two and half tons of fodder corn, or much more than enough to have paid for the replanting.

In figuring the loss from a missing hill, two items have to be taken into account, the loss from the hill itself and the gain to the hills around it.

The first is easily told by taking the average weight of the hills which are surrounded by four full hills. The second is not so easy to ascertain. One way of estimating is to get the average weight of those hills that are next to a missing hill and compare this weight with the weight where the hills are full.

In the field the first year there were 114 hills which had a missing hill on one side of them, with an average weight 6.8 pounds. The 122 hills that were surrounded by complete hills average 6.0 pounds. This indicates an average gain of 0.8 pounds to each of the four hills surrounding a missing hill or a total gain of 3.2 pounds. But since the average weight of the hill in this field was 6.0 pounds, each hill that was missing meant a loss of 6.00 pounds and a gain of 3.2

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pounds or a net loss of 2.8 pounds which is equal to 47 per cent.

The same thing was tried in another field of much heavier corn. The 165 hills surrounded by four full hills averaged 10.11 pounds each or fully twenty-five tons of fodder corn per acre. The 248 hills that were next to a missing hill averaged 10.77 pounds; a gain of 0.66 pounds for each of the four surrounding hills, making a gain of 2.64 pounds. The loss for each missing hill is 10.11 pounds and the gain 2.64 pounds, at a net loss of 7.47 pounds or 74 per cent.

Another field of rather light corn gave somewhat different results. The 216 hills near a missing hill weighed 4.27 pounds and the 392 hills fully surrounded weighed 3.52 pounds each. Here is a gain of four times 0.75 pounds or 3.00 pounds as compared with a loss of 3.52 pounds or a net loss of but 0.52 pounds equal to 15 per cent.

The three fields show most widely different results and it is evident that these differences are due to the different vigor in the growth of the crop. When a crop is of such a large rank growing variety as in the second case, and there are stalks enough in the hill to produce the maximum growth, the ground is so full of roots, that even the loss of a hill does not open up enough extra ground to add much to the weight of the surrounding hills compared with the large growth there already. While in a field with a small crop the result is relatively larger. In absolute weight of effect, a missing hill has closely the same result in all three fields. In the field with the light crop it makes a gain of 0.75 pounds for each of the four hills surrounding it; in the field of medium growth the gain is 0.80 pounds per hill and in the field with the very heavy growth 0.66 pounds per hill. The average of these is 0.74 pounds for each hill or about 3.00 pounds for the four surrounding hills. It can be said then that in general a missing hills makes a gain of about three pounds of cornfodder in the weight of the surrounding hills and a loss of the weight of an average hill of the field.

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III. POTATOES.

A—ALFALFA SOD COMPARED WITH OLD LAND.

A test was made of potatoes on alfalfa sod as compared with good land that had been manured two years before and raised one crop of grain and one of corn. There were nine plots of each and though the plots are quite variable, in each case the alfalfa sod gives a larger yield than the old ground. In the plots which are the nearest alike, the yield from alfalfa sod is not quite twice that from the old ground, while in two other plots it is five times as much. The average is about three to one, being 3601 pounds of merchantable potatoes from the alfalfa sod and but 1277 pounds from the old ground.

B—EXPERIMENTS WITH FERTILIZERS,

Experiments in fertilizing the ground for potatoes were made with a complete fertilizer and with kainit, sulphate of potash and muriate of potash. The complete fertilizer was bought in Denver at forty dollars per ton; the potash salts came from the Potash Trust of New York City. The fertilizer was applied at the rate of four hundred pounds per acre.

Plot.	Fertilizer.	Yield of potatoes.
1	Nothing	431
2	Sulphate of potash	430
3	Muriate of potash	488
4	Complete fertilizer	576
5	Kainit	665
6	Nothing	689
7	Sulphate of potash	628
8	Muriate of potash	610
9	Complete fertilizer	409
10	Kainit	383
11	Nothing	273

Combining the plots gives the following averages :

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Sulphate of potash	1058 pounds
Muriate of potash	1098 "
Complete fertilizer	985 "
Kainit	1048 "
Nothing	896 "
Average of fertilized plots	1047 "
Average of unfertilized plots	896 "
Gain from fertilization	14 per cent.

Under ordinary prices this gain of fourteen per cent would just about pay the cost of the fertilizer, but it is evident that part of the difference in crop is due to differences in the character of the ground, so that it would be hardly safe to say that the whole of the gain of fourteen per cent was due to the fertilizer.

IV. SUGAR BEETS.

A—SUBSOILING FOR SUGAR BEETS.

A test was made of the effect of subsoiling the land for sugar beets as compared with simple plowing. The subsoiling was done with a Secretary plow to the depth of fourteen inches, the rest was plowed eight inches deep with a common stirring plow. The field was divided into six equal strips, alternately plowed by the two methods. The field was subsoiled in May and planted the same day. The results are given in the following table:

Plot.	Treatment.	Crop Per Plot.
1	Plowed	2960
2	Subsoiled	6880
3	Plowed	5860
4	Subsoiled	4554
5	Plowed	4040
6	Subsoiled	4400

The average of the three plots merely plowed is a crop of 4287 pounds of sugar beets, while the three plots subsoiled gave a crop of 5278 pounds. This is an apparent increase of 23 per cent as the result of subsoiling.

A second trial made in the same way with four plots gave

Plot.	Treatment.	
1	Plowed	2340
2	Subsoiled	2300
3	Plowed	1470
4	Subsoiled	1956

The average of the plowed plots is 1905 pounds and of

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the subsoiled 2128 pounds, being a difference of 12 per cent in favor of the subsoiled.

The average of the whole ten tests is 18 per cent gain in weight of the crop as the result of subsoiling.

B—SUGAR BEETS IN COLORADO IN 1899.

The results of the experiments with sugar beets in 1897 and 1898 have already been published in former bulletins of this Station. In 1899 the work was not conducted on so large a scale. It was considered that the results of 1898 showed beyond a shadow of a doubt that there were large areas in Colorado that were adapted to the raising of large crops of excellent beets for factory use and that therefore there was no further need of making general distributions of seed for testing this point.

The questions to be considered hereafter are the more special points of how to handle the crop to get the best results. The season of 1899 was devoted to the study of questions concerning the proper time to plant, the best distance between the rows and whether or not the seed should be irrigated at the time of planting. With regard to the first, the results are decisive and that question may be considered as settled. The second was decided, so far as the test went, but the problem is yet left of still closer distances. The third problem was not solved and it remains as one of the two large problems yet to be attacked in Colorado. The solving of either would mean a gain of more money each year to Colorado than the total received from the government for carrying on experimental work. The first problem, broadly stated, is: How shall the irrigation water be handled to obtain a full stand of beets. The second problem is at the other end of the season: What can be done to make the beets ripen thoroughly?

1. TIME OF PLANTING.

Seed was sent to several parties representing the principal beet growing sections of the State with the request that they make four plantings conforming as nearly as convenient to the dates April 15, May 1, May 15 and June 1. The work was done on small plots so as to eliminate so far as possible differences of soil and irrigation and to allow the work to be done with great care. The returns show that the stand of beets was almost perfect in every case and that the crops were large in quantity and of good quality.

The first table gives the facts concerning the planting

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and the second the returns of the harvest. The rows in each case were twenty-four inches apart. In this test and in all the others the seed was sent to the growers from the College and was in each case the Zehringen furnished by the Department of Agriculture at Washington.

RECORDS OF PLANTING.

Name	Place	DATE OF EACH PLANTING.				Date of harvest
		First	Second	Third	Fourth	
M. D. Parmenter	Lamar	April 10	May 1	May 15	June 1	Nov. 10
C. H. Miller	Antlers	" 26	" 5	" 20	" 1	" 20
H. T. Gravestock	Canon City	" 20	" 3	" 15	" 1	Oct. 31
C. H. Gravestock	"	" 20	" 3	" 15	May 31	Nov. 2
J. M. Mortimer	"	" 15	" 1	.....	.....	Oct. 29
Adam May	Debeque	" 15	" 1	" 15	June 1	Nov. 13
Martin Nelson	Greeley	" 24	" 5	" 20	" 10	Oct. 31
I. W. Clapper	Loveland	" 20	" 10	" 20	" 10	Nov. 10
F. Niemeyer	Evans	" 20	" 5	" 20	" 10	Oct. 24
D. G. Edgerton	Carbondale	" 20	" 10	" 20	" 10	Nov. 9
Arkansas Valley Substation	Rocky Ford	" 17	" 2	" 16	May 31	Oct. 21
Agricultural College	Fort Collins	" 18	" 10	" 26	.....	" 21
Average	.....	April 19	May 5	May 18	June 4	Nov. 4

RECORDS OF HARVESTING.

Name	Place	WEIGHT OF CROP IN TONS PER ACRE FOR EACH PLANTING.			
		First	Second	Third	Fourth
M. D. Parmenter	Lamar	39.9	30.2	33.6	27.8
C. H. Miller	Antlers	9.3	10.2	9.9	.....
H. T. Gravestock	Canon City	23.5	24.7	12.2	12.6
C. H. Gravestock	"	11.8	17.5	10.9	10.2
J. M. Mortimer	"	27.7	13.6	Did not grow	
Adam May	Debeque	30.3	29.2	28.1	24.5
Martin Nelson	Greeley	27.0	23.8	10.9	9.5
I. W. Clapper	Loveland	27.2	17.0	8.7	5.6
F. Niemeyer	Evans	65.3	54.4	43.5	32.6
D. G. Edgerton	Carbondale	13.3	8.7	8.0	8.6
Arkansas Valley Substation	Rocky Ford	15.2	16.6	26.0	18.9
Agricultural College	Fort Collins	23.8	20.9	22.7	20.0
Average 12 trials	.....	26.2	22.2	.....	.....
Average 10 trials	.....	27.7	24.3	20.4	15.3

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The results are surprisingly conclusive. They show in the strongest manner the advantage of early planting. And by early planting as used here is meant very early planting, much earlier than has heretofore been considered safe.

From the financial side no argument could be stronger in favor of early planting than these results. The planting of April averages 27.7 tons per acre, with a steady decrease to 15.3 tons for the first of June. It has usually been considered that from May 10 to May 20 was the best time to plant beets in Colorado. The difference between the first and third plantings is 7.3 tons per acre, which means a loss of $31.00 per acre by the late planting.

The results at Fort Collins show strikingly how much cold the sugar beet plant can stand and thrive. The first planting was made April 18. The ground was in fine moist condition from a heavy rain and the beets germinated at once. The nights were cold, i. e. below freezing, until April 24; then followed a week of warm weather with four frostless nights. The first week in May was cold and on May 4, the temperature fell to nine degrees below freezing. The beets were not at all injured by the cold and made the most nearly perfect stand and the largest crop of all the different plots grown on the farm that year.

Such a test as this is not complete until it is known whether or not the date of planting has influenced the quality of the beet either in sugar or purity.

Through the courtesy of the Division of Chemistry of the Department of Agriculture at Washington, most of the analyses of the beets were made by them. The beets were carefully wrapped in oiled paper and sent by mail. In several cases the beets were weighed before sending and then weighed in Washington before analyzing to determine the amount they had dried out. The loss was surprisingly small. The average was less than three per cent of shrinkage. The analyses are given as made on the samples as they were analyzed at Washington and are therefore this small amount, about one thirtieth, too high. We are indebted to the Colorado Sugar Co., of Grand Junction, Colorado for the analyses of nearly a hundred samples of beets grown on the College Farm at Fort Collins. In these cases the shrinkage in shipping the samples was very carefully noted and the analyses, as given later, are all corrected to indicate the condition of the beets when harvested.

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RECORDS OF ANALYSES.

Name	Place	PLANTING.							
		First		Second		Third		Fourth	
		Sugar in beet	Purity	Sugar in beet	Purity	Sugar in beet	Purity	Sugar in beet	Purity
M. D. Parmenter	Lamar	11.2	75.7	14.0	79.9	10.5	71.9	13.1	76.7
C. H. Miller	Antlers	14.5	79.3	14.1	77.9	15.8	82.2	.....	.....
H. T. Gravestock	Canon City	17.5	84.0	20.3	88.4	19.6	86.9	20.5	90.8
C. H. Gravestock	"	19.4	88.3	18.6	89.1	19.5	90.3	17.1	85.3
J. M. Mortimer	"	16.3	84.3	17.9	85.1	.....	.....	.....	.....
Adam May	Debeque	12.4	76.5	14.3	82.9	13.6	77.7	13.6	78.6
Martin Nelson	Greeley	17.0	84.0	15.1	83.3	16.7	85.9	16.2	86.7
J. W. Clapper	Loveland	14.2	84.2	16.0	82.8	16.3	85.1	13.6	76.5
F. Niemeyer	Evans	13.8	81.0	14.2	83.7	14.3	78.9	16.6	85.8
D. G. Edgerton	Carbondale	14.7	83.3	15.1	85.0	15.2	86.5	14.1	84.1
Average		15.2	82.1	15.96	83.8	15.7	82.4	15.6	80.6

It will be noticed that there is scarcely any difference in the average analysis of the crops from the different plantings.

The second planting averages a trifle the best in both sugar and purity, but not anywhere near enough to offset the much larger yield of the earlier planting.

It can be said that taking into account all the factors of the problem there is a decided advantage in early planting; it gives a better stand, produces a larger crop and this crop is of good quality in sugar and purity.

For the sake of convenience in thinning the beets it is not advisable to plant all the crop at one time. The best way is to plant a third of the ground as early as possible, as early as one can be sure of water to irrigate up the seed if necessary and as soon as it seems warm enough to germinate the seed. Then put in the second third as soon as the first planting appears above the ground and the last within the next ten days.

2. DISTANCE BETWEEN ROWS.

Where sugar beets are raised by the natural rainfall it is customary to plant the rows as close together as it is possible to get a horse through them to cultivate. The present writer has seen a hundred acre field of beets in

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Nebraska where the rows were but fourteen inches apart. Many experiments have shown that a sugar beet to do its best needs one square foot of ground. If then the rows could be made twelve inches apart and the beets thinned to twelve inches in the row we should have the largest possible crop per acre of the highest sugar and purity.

Where the beets are raised by irrigation the rows must be far enough apart to allow an irrigating furrow to be run between. It will not do to allow the water to run against the beet itself, because it injures the crown of the beet and lowers the sugar and purity. The water must be kept in the furrows and the sides of the furrow made high enough to carry the water over any small irregularities in the surface, the water soaking sideways through the ground to the beet. If the surface of the land was an absolute plane, a furrow three or four inches deep would be an abundance and such a furrow could be made in rows eighteen inches apart. In our tests on the College farm we have grown many fields of beets successfully in eighteen inch rows where the land was in the best possible condition. But where the land is not properly smoothed, an eighteen inch space in not enough to throw up a furrow high and deep enough to keep the water off the beets. Under most conditions, with gently sloping or nearly flat ground and long rows, twenty-four inches apart is none too much for ease in irrigating. The twenty-four inch row will not raise so large a crop per acre as the eighteen inch row.

A set of experiments was made to determine whether it is possible to get the benefit of the large space for furrowing and irrigating while at the same time obtaining as large a crop as would be gotten from rows close together. The rows were planted alternately eleven and twenty-seven inches apart. All the irrigating was done in the twenty-seven inch space, while the beets on the two sides of the eleven inch space were so near together that after the thinning and the first hoeing, they shaded this small space and it required no further attention. The two rows together occupied thirty-eight inches, an average of nineteen inches per row. These plots were planted side by side with those in which all the rows were twenty-four inches apart and which were irrigated between each row. This second method, and also the method of eighteen inch rows, require twice as many irrigating furrows as the twenty-seven and eleven inch furrows.

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The results are given below.

DISTANCE BETWEEN ROWS.

Name	Place	WEIGHT, CROP, TONS PER ACRE.	
		Rows 24 inches apart	Rows 27 and 11 inches apart
M. D. Parmenter	Lamar	30.9	40.8
C. H. Miller	Antlers	10.2	13.8
H. T. Gravestock	Canon City	25.1	26.4
C. H. Gravestock	"	14.2	14.3
J. M. Mortimer	"	13.6	24.8
Adam May	Debeque	27.6	35.8
Martin Nelson	Greeley	25.5	31.2
I. W. Clapper	Loveland	15.1	13.6
F. Niemeyer	Evans	54.2	66.0
D. G. Edgerton	Carbondale	9.8	13.2
Arkansas Valley Substation	Rocky Ford	16.8	17.8
Agricultural College	Fort Collins	19.8	22.1
Average		21.9	26.71

The results are strongly in favor of the twenty-seven and eleven inch rows. It is not claimed that this method will give a larger yield per acre than all eighteen inch rows, but it is believed that it will give just as large a yield and can be profitably used on ground where it would be very difficult to use the eighteen inch row. The twenty-seven inch row is so wide that it allows an abundance of space to put in a big furrowing plow, use a good head of water and run a given stream a long distance—in other words, do a good thorough job of irrigating.

3. IRRIGATING THE SEED.

This is the most troublesome problem before the Colorado sugar beet raiser at the present time. If all seasons were the same in the rainfall, the problem would soon be solved. The years 1894 and 1900 show the possible extremes in this matter. In 1894 wheat that was sown the fall before did not germinate until the ground was irrigated the last week in May, and yet, wheat requires much less moisture to germinate than beet seed. In 1900 the month of April was as wet out here in the arid region as it usually is along the Atlantic or Gulf coasts. The ground was too

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wet to be worked, and the beets put in the first week of May made an absolutely perfect germination without irrigation.

The year 1899 may be considered a fairly normal year for the earlier plantings and rather dry for the later. The tests of irrigating up the seed were made about the first of May, when the conditions were not far from an average. The plots were all planted on ground that had not been irrigated, and then half of them were allowed to depend on rain for the water necessary to germinate the seed, while the other half was irrigated the same day the seed was planted.

The following table shows the results of the two methods:

IRRIGATING THE SEED.

Name	Place	WEIGHT, CROP, TONS PER ACRE.	
		Seed irrigated at planting	Seed not irrigated at planting
M. D. Parmenter	Lamar	35.3	36.5
C. H. Miller	Antlers	12.0	Did not grow
H. T. Gravestock	Canon City	27.8	23.7
C. H. Gravestock	"	16.3	12.2
J. M. Mortimer	"	19.2	Did not grow
Adam May	Debeque	32.6	30.7
Martin Nelson	Greeley	26.2	30.5
I. W. Clapper	Loveland	15.0	13.8
F. Niemeyer	Evans	59.9	59.0
D. G. Edgerton	Carbondale	11.2	11.8
Arkansas Valley Substation	Rocky Ford	17.8	16.9
Agricultural College	Fort Collins	22.3	19.6
Average		26.3	25.4

Although the general average is in favor of irrigating up the seed, the figures of the individual plots show some for and some against it. There seems a probability that no uniform rule will apply to the whole of Colorado, but it is safe to make this a rule. Prepare for irrigation at time of planting; if within five days after planting, the seed shows no signs of swelling and sprouting, turn on the water and keep the ground wet until the plants show a full stand.

4. VARIETY TESTS.

Four varieties of sugar beets were grown on the College

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farm in 1899 and all four were grown both on a heavy clay soil and a clay loam. The records of the harvest and analysis are given below. The Zehringen and the Vilmorin No. 1, were sent by the Department of Agriculture at Washington, while the Vilmorin No. 2 and the Kleinwanzlebener were furnished by the Oxnard Sugar Co., of Norfolk, Nebraska.

All the samples were taken October 21.

VARIETY TESTS.

Variety	Crop per acre Tons	Total Solids	Sugar in juice	Purity
Heavy clay soil—				
Zehringen	22.2	18.74	14.55	77.5
Vilmorin No. 1	20.9	20.21	16.29	80.8
Vilmorin No. 2	20.4	18.69	15.08	80.2
Kleinwanzlebener	17.9	18.67	13.73	73.6
Clay loam—				
Zehringen	....	18.18	15.75	86.8
Vilmorin No. 1	....	17.55	14.33	81.7
Vilmorin No. 2	....	18.85	16.38	86.9
Kleinwanzlebener	....	17.61	14.07	79.9

Analyses were made of the beets from the different plots grown on the College farm in 1899 and are given below. The variety used in each case was the Zehringen sent by the Department of Agriculture at Washington.

Date of planting	Remarks	Crop per acre Tons	Total Solids	Sugar in juice	Purity
April 18	24 inch rows, not irrigated	23.8	18.59	14.86	78.0
May 4	" " " "	22.2	18.74	14.55	77.5
" 10	" " " "	20.9	17.86	14.74	82.6
" 10	" " " "	18.7	17.64	14.00	79.4
" 10	" " irrigated	20.9	17.74	14.28	84.4
" 10	27 and 11 inch rows, not irrigated	20 5	17.58	14.06	80.2
" 10	" " " irrigated	23.7	18.57	14.87	80.3
" 10	24 inch rows, seed soaked	24.5	17.57	13.75	78.2
" 10	" " half the seed soaked	27.5	17.96	14.19	80.1
" 26	" " not irrigated	15.3	16.18	12.62	78.0
" 26	" " irrigated	22.7	17.08	13.78	80.5

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5. SUMMARY OF BEET TESTS, 1899.

Different dates of planting.

April 19	20.7 tons per acre
May 5	24.3 " " "
May 18	20.4 " " "
June 4	15.3 " " "

	Sugar in beet. Per Cent.	Purity. Per Cent.
April 19	15.2	82.1
May 5	15.9	83.8
May 18	15.7	82 4
June 4	15.6	80.6

Distance between rows.

24 inches	23.7 tons per acre
27 and 11 inches	28.1 " " "

Irrigating up the seed.

Irrigated, all grew	26.3 tons per acre
Not irrigated, two failed, the rest	25.4 " " "

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Bulletin 58. **August, 1900.**

The Agricultural Experiment Station

OF THE

Agricultural College of Colorado.

A Soil Study.

PART II.

The Crop Grown: SUGAR BEETS

—BY—

WILLIAM P. HEADDEN.

PUBLISHED BY THE EXPERIMENT STATION
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The Agricultural Experiment Station

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The publications of the Experiment Station are of four classes:

1. **BULLETINS.** These are distributed, as far as the editions permit, to those interested in Colorado agriculture. They comprise bulletins on irrigation matters, sugar beets, alfalfa, barley and other field crops, cattle and sheep feeding, strawberries and other small fruits, insects, etc.

2. **ANNUAL REPORTS.** These are largely administrative and technical, printed in small editions, and not ordinarily sent to individuals except on request.

3. **PRESS BULLETINS.** Shorter statements of experience in various lines, or information needing immediate distribution. Sent to papers and to individuals according to the subject matter.

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A Soil Study:

Part II.* The Crop Grown: SUGAR BEETS.

By WILLIAM P. HEADDEN, A. M., Ph. D.

INTRODUCTORY.

PREVIOUS WORK OF THE STATION ON SUGAR BEETS.

§ 1. This Station has already published nine bulletins on the subject of sugar beets, seven of which have been devoted to the demonstration of the fact that remunerative crops of sugar beets can be grown in the irrigated sections of this State up to altitudes of 7,800 feet. The earliest experiments recorded, 1888, show a trifle over 12 per cent. of sugar as the maximum per cent. present in any of the varieties experimented with. The only object aimed at in the experiments of that year seems to have been to determine whether the beet could be successfully cultivated under our conditions. The results were most encouraging, both in regard to the percentage of sugar present in the beets and also the tonnage, which ranged from 24 to 30 tons per acre. This yield was estimated from the product of an average row 450 feet long.

§ 2. The experiment of 1888 was not continued in 1889, but another line of work was undertaken, namely, to study the effect of various soils upon the composition of the ash, the percentage of the sugar, and on the feeding value of the beets. The results of this investigation were published in 1890 as Bulletin 11.

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* Part I., forming Bulletin 46 and issued in 1898, is out of print. Most of the reports of the Station have something about sugar beets. Of the bulletins treating of sugar beets, none but 36, 51 and 57 can be supplied, except to libraries. Those printed are as follows:

7. Potatoes and Sugar Beets. April, 1889. Profs. Cassidy and O'Brine.
11. Sugar Beets. April, 1890. Director Ingersoll and Dr. O'Brine.
14. Progress Bulletin on Sugar Beets. January, 1891. Dr. O'Brine.
21. Sugar Beets; Potatoes; Fruit Raising. October, 1892. F. L. Watrous.
36. Sugar Beets. March, 1897. Prof. Cooke and Dr. Headden.
42. Sugar Beets in Colorado in 1897. February, 1898. Prof. Cooke and Dr. Headden.
46. A Soil Study. Part I. The Crop Grown: Sugar Beets. June, 1898. Dr. Headden.
51. Sugar Beets in Colorado in 1898. March, 1899. Prof. Cooke.
57. Farm Notes. Alfalfa; Corn; Potatoes; Sugar Beets July, 1900. Prof. Cooke.
58. A Soil Study. Part II. The Crop Grown: Sugar Beets. August, 1900. Dr. Headden.

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§ 3. During the season of 1890, Pres. Ingersoll, who was the Director of the Station, and Dr. O'Brine, Professor of Chemistry, joined in a study of the general condition and outlook for the beet sugar industry; while the Horticultural and Chemical Departments cooperated in further study of the sugar beet. The specific subjects with which they experimented during this season being a study of the effect of the distance between the beets in the row upon the amount of sugar contained in the beets, and of the relation between the size of the beet and its sugar content.

§ 4. A number of persons had, by this time, become sufficiently interested in the subject to grow sugar beets and send them to the Station for analysis. The descriptions of the samples, as received at the laboratory, were very imperfect, as was to be expected, but the results obtained fully justified the conclusion of Bulletin 14, which I can do no better than to quote:

> We believe that it has been established that the soil and climate of Colorado are favorable to the production of sugar beets, and that they can be successfully and profitably raised to the advantage, both of the farmer and manufacturer.

§ 5. Experiments were continued during the years 1891 and 1892, not only by the Station at Fort Collins, but also at the Substations in the San Luis Valley, Arkansas Valley and the Divide, also by individuals in the Arkansas Valley and in the neighborhood of Fort Collins. The chief importance seems to have been attached to the endeavor to determine how much irrigation is required to produce the best results, and to notice the effects of both too little and too much irrigation upon the crop, and the percentage of sugar in the beet. The effect of the distance between the beets in the row was also studied, but was subordinated to the questions of irrigation and cultivation. The results obtained at the Arkansas Valley Substation at Rocky Ford during these years, 1890 to 1892, were published in Bulletin 21, October, 1892. The rest of the results were not published until March, 1897, in Bulletin 36, which contains a succinct statement of the results recorded up to that date; some of which, about one third, had not been published in any previous bulletin.

§ 6. In the spring of 1897 the public seemed sufficiently interested to justify the Station in again taking up the subject, and having received quantities of seed from the Department of Agriculture at Washington, and also from other sources, it was distributed to persons in different sections of the State, together with explicit instructions how to plant, to cultivate, and especially how to harvest the samples for analysis. The results obtained were, more satisfactory data concerning the time of planting, cultivation and harvesting of the crop. In addition to this, experiments were made at a greatly increased number of localities throughout the State. In

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other words, the experiments were greatly multiplied and made simultaneously. So far as quantity and quality of crop was concerned, we only corroborated the results of previous years, *i. e.*, that the soils of Colorado produce beet crops which compare favorably with those produced elsewhere, where the beet sugar industry has proved a profitable venture. There was added to this the results of a study of the conditions at and around the beet sugar factories of Nebraska, Utah and New Mexico, making the statement of facts concerning this industry as complete as possible, and giving the public the fullest possible data wherefrom to draw their own conclusions as to the advisability of engaging in this industry.

§ 7. At this time, the season of 1897, the Department of Chemistry began an independent investigation, whose principal object was a study of the chemistry of the crop as affected by an alkalized condition of the soil. This work traversed a number of questions pertaining to the crop in a fuller and more systematic manner than had previously been done. The sugar in the beets was determined weekly, beginning September 2, and continued until October 13, when the crop was harvested; and from time to time till January 8, 1898, in beets left in the ground and covered with straw to protect them against severe freezing. This gave us data respecting the effect of alkali upon the amount of sugar present and its effect upon the time of maturing; the composition of the ash at various periods of growth, the distribution of both sugar and ash constituents in the beet, the composition of the beets and leaves in regard to their feeding value, the total dry matter in the leaves and roots, its quantity in the respective thirds of the latter, etc. The results of this year's work are contained in Bulletin 46. In 1897 the Station carried on two lines of experimentation with sugar beets, one economic and the other almost purely chemical, resolving itself into a soil study, which it was intended to be.

The work was continued in 1898 and 1899. Some of the results of 1898 have already appeared as Bulletin 51. This consists of more extended experiments upon the effects of the date of planting, methods of planting, time of thinning, distance between plants in the row, experiments with varieties, and a comparison of home grown and imported seed in regard to the quality of the beets produced.

§ 8. The following pages record the further observations made during the years 1898 and 1899, being, in fact, a continuation of Bulletin 46, and for that reason a few of the conclusions of that bulletin are reproduced here:

The effect of the alkali, present in our soil, upon the sugar content of the beet is not, of itself, detrimental.

The maturing, or ripening, of the crop corresponds to an increase of from 2 to 3.5 per cent. of sugar in the beet, and about one third of the total yield of sugar.

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The rate of drying out of beets is about 5 per cent. for the first 24 hours, but by the end of five days it falls to about 2 per cent. and remains practically constant for the next twelve days.

The weight of the leaves of Colorado grown beets equals about 87 per cent. of the weight of the roots. The weight of the leaves does not increase materially during the last six weeks of the growing season, but during this time the weight of the root increases by 64 per cent. of its weight at the beginning of the period, or 39 per cent. of the weight of the mature beet.

The presence of alkali increases the weight of the leaves very slightly, but has no marked influence on the date of maturing.

As the sugar is formed there is a disappearance of dry matter, other than sugar, in the beet, suggesting the formation of the sugar in the root by the transformation of substances already deposited therein.

The effect of alkali upon the percentage of ash in the roots is to increase it by about 2 per cent., reckoned on the dry matter.

The composition of the ash of the beets seems not to have been affected by the different character of the soils experimented with, either because there was so great an abundance of available, and to the plant, acceptable, mineral matter present that it was not affected by the presence of a large quantity of other salts, or the composition of the ash of the sugar beet is very constant. I think that the latter is the case. The composition of the ash is represented by the following approximate percentages: Sulphuric acid, 3.5; phosphoric acid, 7–9; alkalies, 48–52; lime, 2–3; magnesia, 6; chlorin, 11.50–14.50; carbon dioxid, about 15.

The ash of the beet leaf has a general composition which, like that of the beet, is the same throughout the season, except that there is an increase in the chlorin as the plant approaches maturity.

§ 9. The trials in different parts of the State in 1897 aroused sufficient interest in the possibilities of the sugar industry in Colorado, for the resources of the Station to be supplemented by aid from the United States Department of Agriculture, from the Chamber of Commerce of Denver, and from various counties in the State. This aid was largely given through the solicitation of the Chamber of Commerce, and was principally in form of prizes to induce growers to compete for good results. The field trials were directed by Prof. W. W. Cooke. Over 800 analyses were made by the Station. The results of these tests, together with the study of the best methods of growing sugar beets, is given in Bulletin 51.

§ 10. Some additional tests on methods of cultivation, dates of planting, distance between rows, and irrigating the seed are given in Farm Notes, Bulletin 57, by Prof. W. W. Cooke. These are the results of cooperative trials with growers in different parts of the State. The same bulletin reported the results of the tests made throughout the State in cooperation with the Department of Agriculture and the Chamber of Commerce.

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THE CHEMICAL WORK OF 1898 AND 1899.

DESCRIPTION OF THE CONDITIONS.

§ 11. The plot on which the beets were grown in 1898 was the same as that used in 1897. The character of this plot having been fully described in Bulletin 46, p. 5, it will not be repeated in this place. The cultivation of the preceding season and the effects of the soil remaining thrown up in ridges over winter, exposing it to the weathering action of the season, tended to better its mechanical condition. This was, as I stated in Bulletin 46, the result most desired in order to reduce our study to the question of the effect of the alkali upon the crop. In addition to the weathering, effected as above stated, I endeavored to further modify the mechanical condition by the application of manure and straw. The plot was divided into sections one hundred feet long and twenty-five feet wide; alternate sections received an application of manure at the rate of sixty-four tons to the acre, and one section of the plot, the most difficult one to handle, received a dressing of cut straw at the rate of fourteen tons to the acre.

My object was twofold: First, to study the effect of the manure upon the soil; second, to observe its effect upon the crop.

The straw was used that we might be able to judge, in a measure at least, of the relative effect of the manure as a mechanical agent and as a fertilizer. The crop raised was, as in 1897, sugar beets, and we were successful in getting the same varieties, but the seeds were from different lots, for the crop of 1898.

The cultivation was similar to that received by the preceding crop, but having gotten rid of a patch of poverty weed on the south side of the plot, we were not troubled by insects to nearly the same extent as during 1897, still both of the beetles, *Systena taeniata* and *Monoxia puncticollis*, observed then, appeared again and did some damage. We, however, did not have recourse to the use of insecticides as in the preceding year. In our case we found that removing the poverty weed and keeping our crop well tilled sufficed to keep the beetles down to such an extent that the damage done by them was not serious.

The alkali appeared nearly as bad as heretofore, and we had trouble with the same sections that had previously given us trouble.

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The corroding effects of the alkali was observed, but not to the same extent, and the spots of ground showing it were not so large as in 1897. There was a small spot in which but few seeds germinated; there seemed to be an abundance of moisture, the seed were found at a depth of an inch and a half, and the mechanical condition of the soil was good. This failure of the seed to germinate, for they did not come up at any time during the season, remains unexplained. It was observed that some beets in this part of the patch continued to come up for weeks after the first had made their appearance, especially after irrigation. It is very improbable that this was due to lack of moisture, for this was observed in a very wet portion of the patch, but not the wettest, nor indeed is it more strongly alkalized than some other parts of the plot. The analyses of the soils taken from these spots, and those of the ground waters also, show a larger amount of magnesia present than in other places within the plot; this is more markedly the case with the ground waters than with the soils. Experiments show that magnesic sulfate retards the germination of seeds, but neither the soil nor the ground water, nor yet the water-soluble portion of the soil, shows a sufficient quantity of magnesic sulfate to account for this. The inorganic substances present do not suggest any solution for the failure of the seed to come up.

THE WATER CONDITIONS.

§ 12. The ground was very wet in the spring, so much so that it caused a delay of two weeks or more in planting. The crop was not planted till June 4; some of it not till June 13. This, however, was not due to the condition of the soil. The only irrigation that we were able to give this crop was given from July 8 to 10, and this was with seepage water, of which we had only a scant supply, so scant that we could not obtain any sample of off-flowing water. But a few days later, a heavy rain having fallen in the mountains to the west of us, more than doubling the flow of the river, a large quantity of water was turned into the Larimer County Ditch No. 2 and its laterals. One of our dams was washed out and the lower portion of our beet plot flooded. This happened between the afternoon of the 13th and the morning of the 14th of July. The drains for receiving the off-flow water were immediately opened and the water turned out of the ditch. Samples of both on and off-flow water were taken. The patch drained rapidly, the surplus water being removed in about three hours. This was the only irrigation that the crop received. The total rainfall for the months of July, August, September and October was 2.8 inches. The total amount of water received by the crop, from the time of planting till harvested, was about eight inches. The ground was wet at the time of planting and the water plane was within less than two feet of the surface.

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The level of the ground water fell about a foot in the next 30 days. The irrigation given from the 8th to the 11th was not sufficient to raise the level of the ground water quite as high as it was at the time of planting and it then fell rapidly, making a fall of almost exactly two feet in eleven days. This fall represents the rate of drainage and evaporation. The weather was hot and evaporation was rapid, but that drainage was active can scarcely be questioned. Especially so because the water level in the adjoining, and lower lying, land had not been raised and there was only our small and local supply of water to be removed.

The water level, at a point about two hundred feet to the east of my plot, was not at any time sensibly effected by the irrigation of my plot. The well, the measurements of which form the basis of this assertion, is not very far from an underdrain, perhaps 75 feet from it, but I do not think this fact has very much, if anything, to do with our failure to perceive any change in the level of the water in this well. I think it more likely that the amount of water used was simply insufficient to force its way so far through the soil.

§ 13. This is not the place I intended to discuss the question of water, further than to state the supply furnished to the crop, but it was observed that the different wells fell at very different rates. I have given the maximum fall for the eleven days immediately succeeding the 14th inst. From this date on the water plane fell slowly until it reached its greatest depth for the season during the first week of October. But during the next fourteen days it rose a foot, in some of the wells rather more.

§ 14. The water level at the lower end of the plot ranged, from the end of July to October 10, from 3 to 4.5 feet below the surface, and there were but few beets in this section, as was repeatedly noted in Bulletin 46, but at the western, or higher end, the water level was from 5.2 feet to 6 feet below the surface, and the crop was excellent. At an intermediate point we have the water level ranging, during this same period, from 3.5 to 4.5 feet, with an abundance of alkali and yielding a good crop. With a part of the facts before us it would be easy to justify the inference that beets will not grow where the water plane is from 3 to 4.5 below the surface, but in view of other facts, observed at the same time, we hesitate to offer any statement relative to the cause of the failure of the crop to grow in the section in question, either in regard to the alkali or the water.

§ 15. Notwithstanding the nearness of the water to the surface of the ground, the crop showed the need of water throughout the latter part of the season; our field notes showing that on July 22 the beets were wilted and the water plane low. The weather

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was hot and the wilting may have been dependent upon this as much as upon a lack of water in the soil, but on August 13, it is remarked that the crop needs water and on the 17th the condition of the ground is designated as dry, though we had had in the meantime, August 4 and 5, a rain fall of 0.78 inch. The ground had been kept as mellow as possible and free from weeds, having received, in all, five cultivatings and five hoeings.

§ 16. There was no need of irrigating the plot during the season of 1899, though we gave it a thorough soaking from August 31 to September 2, not because the crop needed it, but for the purpose of puddling the ground and of studying the changes which took place in the water by its contact with the soil.

§ 17. The chief cause of our abundance of water was the fact that we received a sub-irrigation July 1 to 7, coming from the western part of the farm. There is a drain immediately west of my plot which should have taken off the greater part of this underflow, but it did not prevent my plot being filled nearly to the surface with water. The water plane being raised to within 18 inches of the surface, as was proven, not only by the water in the wells, but also by several holes dug in order to verify this observation. This development was something entirely new. I knew that the stratum of gravel underlying the plot was filled with water and that there was probably a flow to the eastward through it. I thought that it came from a more distant source, believing that we were fully protected against sub-irrigation of this sort by a ditch constructed to utilize the seepage water gathered for a mile or more to the westward of us, and further, by the drain alluded to. I believe that these two really gather all the water that, under ordinary conditions, drains from the higher land to the westward of us, but in this instance an unusual supply of water enabled the Farm Department to run water night and day for a week, with the result that the water found its way down into and filled up my lower lying land. The wetness of the land interfered with the cultivation of the crop, but the mechanical condition of the soil was greatly improved over that of the preceding seasons, so that the cultivation was much easier than in 1897 and '98.

§ 18. The ground was not disturbed after the irrigation of September 2, but it was allowed to bake and harden as much as it would. This crop was cultivated twice, hoed twice and irrigated once.

In 1898 the crop was irrigated but once, because we could not get water to irrigate with. This single irrigation was only a light one, applied July 8 to 10, and a part by accident on July 14. Subsequently the ground became very hard, in spite of our efforts to keep it mellow. In 1899 we sought to pack and allow it to be-

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come hard and dry after the irrigation of September 2. The crop, taking the whole patch, was in 1898, 13 tons to the acre, and in 1899, 14.5 tons. I attribute the increased crops to the improvement in the condition of the soil and to a rather better stand, without considering whether this latter was due to the improved condition of soil or not.

THE EFFECT OF THE MANURE UPON THE STAND AND THE BEETS.

§ 19. The effect of the manure was very marked, improving the stand by at least 10 per cent. I believe that under ordinary conditions the effect of so heavy a dressing of manure would not be followed by an improvement in the stand, but in our case it was; the weather conditions turning favorable just after the planting.

The planting took place on May 11, followed by a rainfall of over 1.5 inches during the rest of the month, which was well distributed, rain falling on twelve of the remaining twenty days of the month. Had this not been the case, it is a question whether the manure might not have facilitated the drying out of the soil sufficiently to more than offset its stimulating effect upon the germination of the seed. As it was, the seed germinated better, the plants were more vigorous throughout the season, and the weight of the crop was greater; but the shape of the beets was inferior, very many of them being rooty, forming a chunky beet with a number of roots spreading out from it, literally covered with masses of fibrous roots. The ratio of tops to roots was not determined, but it was evidently higher than where no manure was used. The six plots used for manuring agreed fully in justifying the above statements. There is no reason to suppose that other conditions would have modified any of these results, except the one already mentioned as possibly exceptional, *i. e.*, that manuring improved the germination and stand. Our observations on the effect of coarse manure, under our conditions, leads to this doubt, which we would not otherwise entertain.

EFFECT OF THE MANURE AND ALKALI ON THE SUGAR IN THE CROP.

§ 20. In 1897 we found that the ripening of our crop, or better, that the formation of the sugar, was much more rapid between October 6 and 13, than at any other period during the season, either before or subsequent to this date. Our results showed that about one third of the sugar contained in the crop made its appearance during these seven days. As the crop of 1898 was later than that of 1897, both in planting and maturing, we did not attempt to follow the development of the sugar throughout the season, but contented ourselves with endeavoring to determine the effects of our alkali and manure upon the date and amount of sugar produced during the period of this maturing process. Our first samples were

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accordingly taken on October 3. These were trial samples taken to help us in judging of the condition of the crop. We had already received a number of samples from the Farm Department, but these varied greatly, and we did not know from which of the different plots the sample had been taken. It was, furthermore, out of the question for us to take the plot most nearly representing the plot taken for comparison in 1897, for this plot had been hastened into ripening by lack of moisture. This was so pronounced, at this date, that the tops wilted to the extent of lying flat on the ground. The soil was dry to a greater depth than that reached in digging the beets. If there had been no other differences, these facts make it evident that we cannot compare these plots, so I shall use another whose history is as follows: In 1891 it received a dressing of manure, was planted to potatoes; 1892, trucked, not manured; 1893, fallow; 1894, rye, crop cut green and removed from plot; 1895–'96–'97, fallow; 1898, planted to beets but not manured. The varieties grown on this plot were Vilmorin Improved, White Imperial, White French and Dippe's Improved Kleinwanzlebener.

§ 21. In the following table we do not see the pronounced increase in the amount of sugar as the season advanced or the crop matured, as shown in the crop of 1897, but the season was very different. In 1897 we had, in the early part of September, enough rain, 0.74 of an inch, to stimulate the beets into an increased growth, after a period of comparative inactivity. This produced a material increase in the weight of the crop, but the relative quantity of sugar was less than before this period. The effect was noticeable for two and a half weeks or more, at the end of which period the sugar had increased again and reached its maximum for the season. In 1898 we had no such an abundance of water as in 1897. We were unable to irrigate more than once, and then far less copiously than in 1897, and the rainfall from August 6 to October 15, a period of 70 days, amounted to only 0.74 of an inch, which is the same amount that fell in four days, September 10 to 14, in 1897. The crop of 1898 received its moisture from the soil, developed continuously under very uniform conditions, and matured without showing a so uniformly large gain at the maturing period. In 1897 this amounted to from 2 to 3.5 per cent.; in 1898 the greatest gain for this period was 1.44 per cent. in two weeks. This observation is true in regard to the Farm plot as well as for our own. Furthermore, it is observable in the records of the Department that there is no such great increase in the percentage of sugar just at the time of ripening, unless the beets were already mature at the time of taking the first samples, which was not indicated by the deportment of the beets when grated, as the earlier samples became very black on being exposed to the air. The Department received a sample harvested September 27, 1898, original Kleinwanzlebener, which

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TABLE I.—EFFECT OF MANURE ON SUGAR, DIFFERENT DATES AND VARIETIES, 1898.

DATE	Number.	(M) Manured. (N) Not manured.	Kleinwanzlebener.		Vilmorin.		Lion Brand.		Sugar.		Imperial.		Dippe's Kleinwanzlebener.		Vilmorin Improved.		White Imperial.		Average of all Varieties.	
			Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.	Percentage of Sugar.	Purity.
October 3	....	M	11.40	73.5	11.12	72 8	12.73	76.5	11.07	74.3	9.50	65.8	.....	.....	.....	.....	.....	.....	.....	.....
	....	N	11.83	75.3	13.30	77.3	14.63	80.2	14.49	82.4	13.16	79.6	.....	.....	.....	.....	.....	.....	.....	.....
October 8	1	M	12.83	79.8	13.53	80.9	15.44	82.4	13.73	79.5	12.92	77.6	.....	.....	.....	.....	.....	.....	.....	.....
	1	N	13.78	78.7	13.78	78.7	14.58	80.6	13.30	80.0	13.49	78.0	.....	.....	.....	.....	.....	.....	.....	.....
	2	M	13 40	83.4	11.80	77.1	13.07	76.0	10.64	73.8	13.26	76.3	.....	.....	.....	.....	.....	.....	.....	.....
	2	N	13.30	76.6	14.49	81.1	13.88	77.5	14.49	84.3	12.40	74.8	.....	.....	.....	.....	.....	.....	.....	.....
	3	M	12.35	78.9	11.82	78.4	13.21	78.0	11.53	76.2	11.97	74.3	.....	.....	.....	.....	.....	.....	.....	.....
	3	N	11.16	75.0	11.88	79.0	12.97	78.4	12.45	76.8	13.54	75.6	.....	.....	.....	.....	.....	.....	.....	.....
Average	....	M	12.89	80.7	12 45	78.8	13.90	78 8	11.97	76.5	12.71	76.1	.....	.....	.....	.....	.....	.....	12.79	78.1
	....	N	12.75	76.8	13.38	79.6	13.81	78.9	13.41	80.4	13.14	76.1	.....	.....	.....	.....	.....	.....	13.30	78.4
October 11	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.75	82.9	13.78	80.0	11 40	71.4	.....	.....
October 15	1	M	13.06	78.9	13.30	81.8	15.33	82.7	14.25	83.2	11.69	74.0	.....	.....	.....	.....	.....	.....	.....	.....
	1	N	9.74	70.6	13.06	79.0	16.86	86.5	13.72	82.0	13.63	79.2	.....	.....	.....	.....	.....	.....	.....	.....
	2	M	12.11	74.9	12.11	76.2	13.06	74.9	10.93	74.4	13.63	81.7	.....	.....	.....	.....	.....	.....	.....	.....
	2	N	13.73	80.7	14.49	81.3	13.78	81.7	13.78	81.2	14.49	80.6	.....	.....	.....	.....	.....	.....	.....	.....
	3	M	13.83	84.7	13.49	85.4	13.82	82.5	12.11	76.7	12.26	77.6	.....	.....	.....	.....	.....	.....	.....	.....
	3	N	10.93	76.5	13.16	80.4	13.54	78.2	12.11	78.1	13.97	80.2	.....	.....	.....	.....	.....	.....	.....	.....
Average	....	M	12.99	79.5	12.97	81.1	14.10	80 0	12.43	78.1	12.53	77.7	.....	.....	.....	.....	.....	.....	13.00	79.3
	....	N	11.47	75.5	13.57	80.3	14.72	82.1	13.20	80.4	14.03	80.0	.....	.....	.....	.....	.....	.....	13.40	79.6
October 18	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.75	81.0	14.25	82.7	11.59	74.0	.....	.....
October 22	1	M	13.06	79.2	12.97	81.4	15.20	83.9	14.49	87.3	13.52	81.2	.....	.....	.....	.....	.....	.....	.....	.....
	1	N	12.83	84.1	13.52	79.8	16.67	90.3	14.11	80.4	14 92	87.4	.....	.....	.....	.....	.....	.....	.....	.....
	2	M	13.61	86.5	11.40	78.5	12.97	79.0	12.97	86.5	13.06	80.9	.....	.....	.....	.....	.....	.....	.....	.....
	2	N	17.10	92.4	15.20	92.2	15.68	88.8	13.06	82.9	13.78	88.0	.....	.....	.....	.....	.....	.....	.....	.....
	3	M	12.83	78.1	11.40	77.7	12.45	73.1	10.60	68.1	13.30	80.2	.....	.....	.....	.....	.....	.....	.....	.....
	3	N	11.97	77.4	12.73	80.8	13.40	75.2	12 59	76.3	15.30	85.4	.....	.....	.....	.....	.....	.....	.....	.....
Average	....	M	13.17	84.6	11.93	79.2	13.54	78.7	12.69	80.9	13 29	80.8	.....	.....	.....	.....	.....	.....	12.92	80.8
	...	N	13.97	84.6	13.81	84.3	15.25	84.8	13.25	78.9	14.67	86.8	.....	.....	.....	.....	.....	.....	14.18	83.9
October 25	2	M	12.83	75.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	2	N	15.20	87.1	15.39	85.4	14.82	81.0	13.59	77.6	15.34	81.7	.....	.....	.....	.....	.....	.....	14.67	83.6
November 1	....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15.77	77.1	13.97	79.2	11.88	70.9	.....	.....

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contained 15.23 per cent. of sugar; a sample of the same variety, harvested November 2, contained 15.12 per cent. of sugar. These samples, harvested thirty-five days apart, show almost exactly the same percentage of sugar, and the coefficient of purity is also quite the same, *i. e.*, 83 and 81.

§ 22. The varieties grown by the Farm Department remained almost constant from October 3 to October 22, only one of the three varieties showing any material gain, and in this case a gain of only one per cent. I infer that this difference in the deportment of the crops of the two years was due entirely to the season, and not to either the cultivation or to the soils. There are three different soils and nine varieties of beets included in this comparison; five of the varieties of beets were grown on our alkali soil and the four others on two different soils. Our soil caused no deviation in this respect, and the conclusion of the preceding years, *i. e.*, that the alkalized condition of our soil produces no effect upon the development of the beet, is corroborated. The statement, however, that the maturing of the beet represents an increase, that is, a sudden increase, amounting to from 2 to 3.5 per cent., now seems to be an extreme variation. The following table showing the results obtained during the season of 1899 strengthen this view; the greatest increase being 1.1 per cent. from October 10 to 24, and we find no further change, though the experiments were continued until November 10:

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TABLE II.—SUGAR IN THE MANURED AND NOT MANURED CROPS OF 1899.

DATE.	Number of Sections.	(M) Manured. (N) Not Manured.	Kleinwanzlebener.				Zehringen.			
			Percentage of Sugar in Beets.	Purity.	Number of Beets in Sample.	Average Weight of Beets. Grams.	Percentage of Sugar in Beets.	Purity.	Number of Beets in Sample.	Average Weight of Beets. Grams.
October 10	1	M	15.10	79.4	12	627.2	14.25	79.8	13	760.0
	1	N	16.34	82.4	12	661.5	14.06	79.6	11	688.1
	2	M	15.01	82.9	14	517.0	13.83	72.1	12	680.4
	2	N	16.34	81.5	12	491.4	16.06	81.3	12	456.2
	3	M	11.88	74.5	14	488.0	11.97	78.4	12	712.8
	3	N	13.97	83.0	12	846.0	14.92	83.8	12	610.0
Average	....	M	13.99	78.9	.....	540.0	13.01	75.1	.....	714.0
	....	N	15.55	81.9	.....	666.3	15.01	81.6	.....	585.0
October 18	1 2 3	M	13.20	77.7	29	666.6	12.88	71.1	18	710.5
	1 2 3	N	14.54	78.8	18	645.5	15.10	80.1	12	583.5
October 24	1	M	15.44	84.6	12	532.6	15.72	81.7	13	572.3
	1	N	15.58	82.8	12	615.8	17.57	89.1	12	496.7
	2	M	15.96	83 7	12	473.1	13.92	78.0	12	646.4
	2	N	15.58	81.9	12	587.2	16.34	84.2	13	527.4
	3	M	13.77	76 8	12	588.2	12.82	73.3	12	884.6
	3	N	14.87	78.3	12	728.3	15.82	80.2	12	538.6
Average	....	M	15.06	81.7	.....	531.3	14.15	77.7	.....	683.3
	....	N	15.34	80.8	.....	643.8	16.24	84.5	.....	517.6
October 27	1 2 3	N	14.06	77.2	30	676.1	14.81	78.7	30	509.8
November 10	1 2 3	N	15.77	82.0	.15	629.2	15.86	84.2	15	543.5

§ 23. The results of 1897, given on p. 13, Bulletin 46, and those of 1898 and 1899, given in the two preceding tables, but more especially the results of 1897 and 1898, because these are compared with beets grown on ground free from alkali and in good tilth, leave no doubt about the effect of alkali upon the quantity of sugar developed in beets grown on soils abounding in these salts; *i. e.*, they are not detrimental so far as the sugar and the coefficient of purity are concerned, nor does it effect the time of maturing.

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THE EFFECT OF THE MANURE.

§ 24. It is usually stated and generally accepted that land on which a crop of beets is to be grown should not receive a dressing of manure immediately before being planted, but that it should receive the manure and be planted to some other crop between the manuring and the planting to beets. As already stated, I manured my plot heavily, 64 tons to the acre, in February, plowed it under in May and planted it to beets. The primary object was to observe its effects on the soil, but it presents an excellent example of the effects of manure upon the crop. I have already mentioned the fact that its effect upon the stand and growth of the crop was evident, and the tables show its effect upon the percentage of sugar and the coefficient of purity. The average for the fifteen samples taken from manured plots on October 3, 1898, is 12.79 per cent. sugar in the beets, with a coefficient of 78.1; the average for the corresponding set from the unmanured plots is 13.30 per cent, sugar in beets, with a coefficient of 78.4; for the samples taken October 15 the averages are: 13.00 per cent. sugar, 79.3 purity, and 13.40 per cent. sugar, 79.6 purity; for October 22 we found 12.92 per cent. sugar, 80.8 purity, and 14.18 per cent. sugar and 83.9 purity. The averages are in harmony with our statement that manuring land immediately before raising a crop of sugar beets on it tends to lower both the sugar content and the coefficient of purity; but its range is only from 0.5 to 1.2 per cent. sugar and from 0.1 to 3.1 in purity, provided we attribute the whole of these differences to the effect of the manure.

§ 25. The effect upon the form of the beets was in our case a much more serious consideration than the diminution of the sugar content and the coefficient of purity. The form of the beets was decidedly objectionable. The bad tilth of the ground of itself tended to the production of ill shaped beets, but the manure made them very rooty, giving rise to a short, chunky beet with several spreading roots and a large mass of fibrous roots. This was very noticeable and common to all of the varieties, but shown in different degrees.

§ 26. The crop of 1899 shows the same results, but the manure, having become more fully incorporated with the soil, effected the form of the beets less than in the preceding year. The percentage of sugar and the coefficient of purity were effected quite as pronouncedly as in 1898. This is evident from the tabular statement of the results for 1899, from which it appears that the manure caused a depression of as much as 2.3 per cent. (See Zehringen, samples taken October 18.) The effects of the manure upon the stand, color of the tops and development of the crop, were almost as

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evident in '99 as they were in '98. The residual value of the manure, judging by its effects upon the second crop, is greater than one would be justified in anticipating. This is largely due, without doubt, to the peculiar resistance to complete decay and humifaction shown by manures in our soils. It is an often observed fact that manure when applied to a tilled crop remains a long time in the soil without undergoing that disintegration which we are accustomed to see in Eastern soils, where there is an abundance of rain and cloudiness prevails for a much larger percentage of the time than with us. This fact was not new to me, but I was of the opinion that the soil, with the water level within from 4.5 to 3 feet of the surface, would remain moist enough, especially when shaded by the tops of the beets, to cause the complete rotting of the manure early in the season, but it was not so. The manure, some of it scarcely decomposed at all, was abundant when the beets were plowed out and can at the present time, two years subsequent to its application, be easily recognized as distinct from the soil. The practical recognition of this is the wasteful custom, still too general, of making no effort to convert the straw and other litter of the farm into manure, or of using the manure to fill mud holes in the roads or dumping it on the commons when it has become necessary to remove it from the neighborhood of the houses. It is a question with the ranchman how to treat the manure so as to get good results without materially adding to the labor of irrigation. This is especially true of cultivated crops. The beets did not produce shade enough to effect, even with the aid of the moisture in the soil, the rotting of the manure.

§ 27. The straw with which we dressed one section did not withstand decay so persistently as the manure. This may be explained by the fact that there was less of it, by its being loose, without any matting together, and by its having been more uniformly mixed with the soil.

§ 28. The effect of the straw upon the sugar content and coefficient of purity is not pronounced, but it is certainly less prejudicial than that of the manure. I cannot say that I observed any effect upon the form of the beets which I could attribute to the direct action of the straw. But its ameliorating effect upon the soil was quite as pronounced as that of the manure.

This is in harmony with the view expressed in Bulletin 46, *i. e.*, that the soil experimented with is so rich in plant food that the effect, if any, of the alkali upon the growth and composition of the crop is obscured, and that it is not the chemical composition but the mechanical condition of the soil which is the factor of greater importance in any endeavor to improve its condition. This statement would be of little importance did it not apply to all of

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the alkali soils that I have seen in this State, which I firmly believe that it does.

§ 29. The numbers of the sections 1, 2 and 3 in the tables have the same signification as in Bulletin 46. Section 3 is described as in very bad condition and low, very wet and alkalized to such an extent that the surface becomes coated to the thickness of from one quarter to upwards of half an inch with alkali. Its condition is, in fact, so unfavorable that I have at all times questioned whether it is not rather to this, than to the alkali *per se*, that the difficulty of growing any thing in this section ought to be attributed. The alkali may be responsible in part for this condition, but there is no question in my mind but that the water is the direct cause of this to a greater extent than the alkali. The very great improvement caused by addition of the manure and straw to this soil is corroborative of this view. I see nothing in the addition of straw to modify in the least the effects of the alkali nor to diminish its quantity, but it does change the texture of the soil, permitting aeration and disintegration to a beneficient extent.

§ 30. The third crop grown on this section still leaves it somewhat doubtful whether we should charge any of the evil to the direct influence of the alkali. A few of the young plants were undoubtedly killed by it, but after they had become established it seemed to do them no injury. I believe it to be of far less injury than it is usually thought to be. Both the sugar content and coefficient of purity of samples taken from this section during the three seasons are slightly lower than in samples taken from the other two sections. There are exceptions to this statement, but they are not of sufficient importance, in number or degree, to cast any doubt on the fact that beets grown in this section are inferior to those grown on the other sections. They have, however, improved in quality during the three years. The average of all varieties grown in 1897 was 10.66 per cent. sugar in beet, with a coefficient of 73.3; in 1898, including both manured and not manured, the average was 12.68 per cent. sugar, 76.2 purity; and in 1899 the average was 14.13 per cent. sugar, 77.1 purity. This is a marked improvement in the quality of the beet. The figures represent the total improvement, including that due to the soil, to culture, and the differences in the season. The two latter are more important than we are at first inclined to think. A good year is a familiar expression, but its equivalent in tons of beets, or pounds of sugar, is a very indefinite notion, especially to those who use it most frequently. Though three years of observation is too brief a time to form an estimate of the seasonal influences on this crop. I am inclined to credit a large share of the improvement in the quality of the crops to this cause, and also something to the

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differences in culture; but after making due allowance for these factors, there remains a decided improvement, due to the improved soil conditions, and, so far as I can now see, this improvement is wholly in its mechanical condition, brought about by the subsoiling, cultivation, manuring and by being left in ridges during the winter, exposing it to weathering. That it is not due to improved drainage is evident from facts which will be dwelt upon at a subsequent time.

§ 31. The important fact in this connection is simply this: That the water table has not been lowered, except temporarily by prolonged dryness or a lack of irrigating water.

In connection with this question, the influence of the height of the water table, an attempt was made to determine the capillary power of the soil. It was necessary to break up the natural compactness of the soil, so we passed it through a 40-mesh sieve and packed it as firmly as we could, by gentle tapping, into a glass tube, 1⅛ inches in diameter. Experimenting in this manner we found that the water had passed upward 31½ inches in seven weeks, and in one year and five months the soil was perceptibly moist at a distance of 45 inches from the water surface, and quite wet at 39 inches from the same. If these figures represent the value of capillarity in the soil in its natural, undisturbed condition, it would seem that our crops ought to have been pretty well supplied with water at all times, there being but a short time when the water level was more than 45 inches below the surface of the ground. The evaporation from the surface in the open field, exposed to a hot sun and the winds, is quite different from the evaporation from a small, shaded and protected surface, such as that exposed in my tubes. I I have made no attempt to determine how much of a part this may play in my experiment; I simply acknowledge that it has something to do with it, and that is all.

§ 32. I was at one time quite doubtful whether there was any drainage at all out of the area which I was cultivating, and thought to test the question by introducing some lithia chlorid into one of the wells and observe how long it would require for it to make its appearance in the adjacent wells. Lithia had been looked for in the analysis of the residues obtained from the ground water, and reported as absent, so I thought that my plan was feasible; but on examining the water more carefully, using larger quantities, I found it present in easily detected quantities. I had samples of the residues from the ground water, obtained during the preceding eighteen months, and an examination of these showed this element to be present at all times. I do not know whether this is true of other soil waters in this region or not. It, however, rendered this means of detecting a flow of water through our plot inapplicable,

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but a subsequent experiment showed that the water level is lowered, by drainage or otherwise, from 0.7 to 1.0 foot in about 36 days. Observations, in 1898, on the rate of the fall of the water level after having raised it by irrigating, showed about 40 days as necessary for a like fall, *i. e.*, from 0.7 to 1.0 foot, in the different wells. The lowest point the water plane has reached below the surface of the ground, at the east end of the patch, corresponding to section 3, at any time during the three years, was 3.29 feet, which is less than the value of capillarity in this soil. Under such conditions of moisture it would seem that, in some respects, it would be an advantage, rather than otherwise, to have a long dry season. Such seems to have been the case, but not more so with this plot than with others more favorably conditioned.

THE DRY MATTER IN THE CROPS.

§ 33. The average percentage of sugar present in the crop of 1898 was materially higher than in the crop of 1897, and the crop grown by the Chemical Department in 1899 was very rich in sugar. I have already stated that in the latter years there was a scarcity of water, and that the rainfall during the latter part of the seasons was small, so that the soil became dry to a depth exceeding the length of the beets. I believed that this had the effect of increasing the dry matter in the beet, just as drying out under any other conditions would have done, and would account, in part at least, for the higher percentage of sugar. Accordingly, samples were taken, thirteen in number, ranging in weight from 800 to 10,500 grams, and the dry matter determined. The results ranged, in 1898, from 18.63 per cent. to 25.62 per cent., with an average of 22.00 per cent., as against 17.39 per cent. in 1897, when the range was from 16.69 to 18.01 per cent. These figures represent four varieties and seventy-two beets. The highest average obtained in 1897 was for the Kleinwanzlebener and Vilmorin, six beets each, which gave 18.95 per cent. as the highest percentage of dry matter, showing that there was an average of 3 per cent. more dry matter present in 1898 than in 1897, or at least one sixth more. In 1899 we find an average of 22.76 per cent., or three quarters of one per cent. more than in 1898; but this is with two varieties only, the Vilmorin and Zehringen. We did not find any difference between the beets which had grown on manured or unmanured sections in this respect. There were variations, but they were not constant in either direction. I think that this difference of from 3 to 3.75 per cent. in the total dry matter is mainly due to the difference in the seasons.

THE DRYING OUT OF BEETS.

§ 34. During the season of 1898 we received a considerable number of samples from different parts of the State and the results

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were uniformly high. An attempt was made to obtain the weight of the fresh samples, but it was very unsatisfactory. I was informed that it was impossible for many of the parties to obtain the weight of the samples sent with any degree of accuracy, and this must have been the case, for quite a number of the samples received weighed more by 250 grams than when they were mailed to us, from three to five days previously. Why the senders should give us such under weights is not easy to understand. In spite of these accidents, we obtained 336 samples which we considered usable, in estimating the deduction to be made from the average percentage of sugar found in order to approximate the actual percentage in the beets in a fresh condition. The amount of drying out was very varying, often evidently too low, and sometimes so high that the result obtained had to be rejected as improbable; but none of the low ones were rejected and are included in the 336 samples used. The correction to be applied as based on these is 1.49 per cent. These samples were all wrapped separately in paper and inclosed in a cotton sack or cloth. As the weights given by the senders were unsatisfactory, I repeated the experiments of 1897 with even more care, having regard to the temperature at which the room was kept during the time of the experiment. The mean temperature for September, during that portion of it in which we received samples, was 61.3°, and for October it was 46.3°, but the mean maxinum was 61.0°. I endeavored to keep the room about 60°. I took 4,660 grams of beets and obtained the following results, the loss being expressed in percentage of weight at beginning of the twenty-four hours.

TABLE III.—SHOWING THE RATE OF DRYING OUT OF BEETS.

Days.	*Weight. Grams.*	*Temperature of Room. Degrees.*	*Percentage of Loss.*
—.....	4660.0	.....	....
1.....	4460.0	57–66	4.39
2.....	4322.0	56–62	3.08
3.....	4182.0	56–57	3.24
4.....	4066.0	57–62	2.77
5.....	3915.0	57–62	3.71
6.....	3801.0	57–62	2.91
7.....	3695.0	57–65	2.79
8.....	3617.0	60–60	2.11
9.....	3547.0	.....	1.93
10.....	3468.0	.....	2.23
11.....	3391.0	57–60	2.17
12.....	3305.0	60–67	2.42

§ 35. The conclusion arrived at in 1897, was that the maximum loss was 5.4 per cent. for the first 24 hours, and that after a few days it fell to about 2 per cent. and remained quite constant up to 17 days. The experiment just recorded was made under similar conditions as those in 1897. The beets were covered with gunny sacking to protect them from light and to protect them from drafts

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of air as much as possible. In 1897 the loss in the first 12 days varied from 30 to 33 per cent. of the original weight of the beets; in 1898 we obtain 29.00 per cent. loss, and after the first seven days the daily loss is roughly 2 per cent.

As but few samples received from different parts of the State were analyzed sooner than five days after being harvested, the deduction of one and one half per cent. on account of drying out is quite within reasonable limits, as according to the most favorable results obtained by experiment, a deduction of upwards of 2 per cent. would be allowable. Our own samples were analyzed within 24 hours after being taken and lost less, and tend to correct the error and justify us in taking the lower figure, 1.5 per cent.

§ 36. The importance of this is apparent if we consider the effect of it in stating the average percentage of sugar in the crop of 1898. We have 813 samples of this crop and the average of the analyses as made is 15.12 per cent., but allowing for the drying out by deducting 1.5 per cent., we have 13.62 per cent. as the average, which I believe is the nearest approach to the truth that we can make.

§ 37. The records of this department show that the average of all samples recorded from 1888 to 1896 inclusive, is 12.8 per cent., according to which the crop of 1898 was above the average.

§ 38. It should be remembered that the question of drying out is of much greater importance in considering small samples sent to the Station than it would be in samples taken from car-load lots sent to a factory. The factory sample would be likely to be nearer correct than the sample sent to some chemical laboratory to be tested.

COEFFICIENT OF PURITY.

§ 39. In connection with the last question, that of the coefficient of purity is of some importance, not as to what extent it is effected by the drying out, but as to how near the truth the ordinary determination comes. Two series of experiments were made, five with Vilmorin and six with Kleinwanzlebener. These beets ranged in sugar from 9 to 14 per cent., and the coefficient obtained by evaporating to dryness to determine the total solids was sometimes higher and again lower than that found by the ordinary method, but the average of the five determinations made with the Vilmorin was the same and that with the six Kleinwanzlebener samples differed by 0.2 per cent. The average obtained as ordinarily determined being higher by this small amount.

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THE EFFECT OF SIZE OF BEETS ON PERCENTAGE OF SUGAR.

§ 40. The impression is that large beets will be low in sugar and that small beets will be rich in sugar. I do not recall having seen it so stated by any one writing on the subject. It is, however, claimed, and that justly, that medium sized beets are apt to be richer in sugar than larger ones, and under ordinary conditions they will be richer than very small ones. It should be remembered that such statements are only true in a general sense and do not exclude exceptions either way. Having seen so many exceptions to the statement that large beets were apt to be poor in sugar, I endeavored to determined the influence of size upon the percentage of sugar.

We sometimes find large beets in a row where the stand is regular, and the large and small beets have, to all appearances, had equal chances, with the general conditions favorable to the formation of beets rich in sugar. Again we find beets grown under conditions which we know from observation to be unfavorable to the growth of beets rich in sugar, whether they are large or small. Again, we know that beets grown from different seed, and on different plots of ground, differ in quality. I shall give examples showing this to be the case with different parts of rows, one end yielding markedly better beets than the other, without regard to size.

§ 41. In order, then, to study whether a large size has any prejudicial relation to the sugar content, I took beets of different sizes grown under the same conditions, *i. e.*, I took all of the beets growing in a certain length of row and analyzed each one separately where they were large enough to make a sample; if not, two were taken together.

This was done with a number of rows, and the results are given in the following table:

TABLE IV.—RELATION OF SIZE OF BEETS TO SUGAR CONTENT.

Number.	*Weight of Beet in Pounds.*	*Percentage of Sugar in Beet.*	*Coefficient of Purity.*
1	4.40	13.35	79.6
2	4.00	14.16	73.0
3	3.25	14.96	81.9
4	2.90	16.06	85.1
5	2.60	14.77	80.8
6	2.40	14.44	76.8
7	1.75	16.96	82.5
8	1.60	15.39	79.7
9	1.50	15.06	81.0
10	1.50	15.68	83.1
11	1.45	16.44	79.9
12	1.20	15.77	85.8
13	0.75	14.73	77.5
14	0.62	15.44	81.0
15	0.62	15.58	83.4
16	0.62	12.97	70.3
17	0.50	14.30	74.5
18	0.40	14.58	78.0

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§ 42. This set of samples shows that beets ranging from 1.20 to 1.75 pounds, Nos. 12 to 7 inclusive, are preferable to either larger or smaller beets. It happens that we have six beets ranging from 2.4 to 4.4 pounds, showing an average of 14.62 per cent. of sugar, and six beets weighing less than a pound each, whose average sugar content is 14.60 per cent. I consider this a reasonably fair test of this point, as the samples are of the same variety and taken consecutively, and from a portion of the rows where the stand was perfect. The beets were mature and in fine condition.

§ 43. Another set of samples was taken of another variety which had grown near an irrigating ditch, and near the edge of the patch. I knew that these conditions tended to the growth of large beets of low quality. But I desired to see what the relation of size to quality was in these. This variety was not known. The seed was purchased for Lane's Imperial, but they were not Lane's Imperial, being a sugar beet of the type of the Kleinwanzlebener, and but little inferior to this variety when grown under like conditions. This variety, under fairly favorable conditions, showed an average of 13.25 per cent. sugar, against 13.97 per cent. for the Kleinwanzlebener. A sample of this variety, grown on my own plot and taken a few days before these, showed 12.59 per cent. sugar, with a coefficient of purity of 77.6.

TABLE V.—RELATION OF SIZE OF BEETS TO SUGAR CONTENT—(Continued).

Number.	*Weight of Beets in Pounds.*	*Percentage of Sugar in Beets.*	*Coefficient of Purity.*
1	8.62	10.59	67.5
2	8.12	10.45	68.3
3	6.90	9.64	62.5
4	5.70	9.50	65.2
5	5.16	10.45	65.9
6	3.15	12.11	72.3
7	2.88	10.45	67.0
8	2.82	9.26	62.1
9	2.71	10.21	64.7
10	2.27	8.46	66.6
11	2.01	9.98	66.0
12	1.78	10.45	66.5
13	1.55	12.35	70.1
14	1.08	10.45	65.9
15	0.25	11.88	69.7

§ 44. This set of samples is no more decisive than the preceding. If it shows anything, it is that beets from one quarter to one and three quarter pounds will be better than larger beets; but taking the individual beets, we observe that the eight-pound beets are as good or better than the one pound sample, and that the three-pound sample is better than the one quarter pound one. The size seems less determinative under conditions of abundant moisture and favorable soil conditions than under others.

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§ 45. Being altogether dissatisfied with the results of these observations, I thought to eliminate the variation in the individual beets by digging a section of a row, dividing the beets according to weight into different samples, and determining the sugar in these. Further, to decrease the chance of error by happening to get either too good or too poor a sample, I took two sections of each row, one from the east half and one from the west half, and further still, I took four varieties. The east half and west half of the patch received the same treatment, except in one particular. The distance to which all of the beets so far mentioned were thinned was from 6 to 8 inches. The results are interesting, and are given in the following table:

TABLE VI.—RELATION OF SIZE OF BEETS TO SUGAR CONTENT—(Continued).

VARIETY.	East Half.						West Half.					
	Number of Sample.	Number of Beets.	Average Weight of Beets.	Average Distance Between Beets in Inches.	Percentage of Sugar in Beets.	Coefficient of Purity.	Number of Sample.	Number of Beets.	Average Weight of Beets.	Average Distance Between Beets in Inches.	Percentage of Sugar in Beets.	Coefficient of Purity.
Vilmorin Improved...	1	9	2.72	7.3	13.11	75.5	....	7	1.51	8.25	15 06	81.7
	2	4	2.49	.....	13.30	75.0	....	13	1.05	.....	16.15	83.3
	3	11	1.56	.....	13.90	79.2	....	9	0.43	.....	15.11	79.5
	4	6	1.05	.....	13.78	78.2	....	....	.....	.....	.....	.....
	5	6	0.62	.....	13.78	75.8	....	....	.....	.....	.....	.....
White Imperial	6	4	3.30	6.99	12.11	69.3	....	3	2.66	6.66	13.07	72.4
	7	9	2.33	.....	10.40	64.8	....	6	1.49	.....	13.68	75.8
	8	13	1.46	.....	11.88	70.9	....	16	0.97	.....	14.73	80.0
	9	11	1.00	.....	11.64	66.4	....	11	0.58	.....	12.88	70.9
	10	12	0 46	.....	12.30	68.1	....	....	.....	.....	.....	.....
White French.....	11	4	3.82	8.13	11.92	76.8	....	11	2.36	9.3	13.68	78.7
	12	6	2.45	.....	14.25	84.3	....	9	1.70	.....	13.44	72.4
	13	4	1.67	.....	14.25	86.0	....	4	1.12	.....	14.20	70.3
	14	4	1.17	.....	13.44	72.2	....	7	0.49	.....	14.73	74.8
	15	13	0.60	.....	13.35	71.9	....	....	.....	.....	.....	.....
Dippe's Improved Kleinwanzlebener...	16	4	2.22	6.3	15.25	76.3	....	14	1.42	6.48	16.63	79.8
	17	7	1.66	....	15.77	77.1	....	11	0.97	.....	16.37	77.9
	18	10	1.09	.....	15.34	75.0	....	12	0.48	.....	16.58	75.7
	19	17	0.48	.....	15.91	74.7	....	....	.....	.....	.....	.....

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§ 46. The beets from the west half are by far better than those from the east half, and this, too, without regard to size, so that the beets from the two halves cannot be compared with one another. The number of beets exceeding 1.5 pounds from the east half stand to those from the west half as more than 2 to 1. The length of row dug was carefully measured, and the distance apart in the row determined; for the Vilmorins it was 7.3 inches in the east, and 8.25 inches in the west half; for the White Imperial it was 6.99 in the east and 6.66 in the west half; for the White French, 8.13 inches in the east and 9.3 in the west half, and for the Dippe's Kleinwanzlebener it was 6.3 in the east and 6.48 inches in the west half. The distance between the beets is well within the generally assumed proper limit. The shortest section of row dug was 20 feet, and the length of the rows was 400 feet.

§ 47. A casual inspection of the table leaves the impression that the beets from the west end of the patch are smaller than those from the east half, and are richer in sugar than these. This is true, but I do not believe that the rest of the inference likely to be drawn, *i. e.*, that it is because of their smaller size that they are richer, is justified. I believe that this depended upon some other factor.

§ 48. It is difficult to satisfy oneself by a study of the results given in this table that there is anything shown by it more definitely than by the preceding ones. Taking each of the samples by itself, that is, comparing beets grown side by side, we find only two sets in the six where there is any decided difference in favor of the smaller beets, and these two are of the same variety, the White French, and the larger beets weigh from 3 to 7 times as much as the smaller beets. We cannot even allow this uncertain advantage to the smaller beets, in regard to coefficient of purity, for, according to the table, the difference is in favor of the larger beets. If from this table we select beets of the same size for comparison, we will find that those from the west end are the richer and better beets. The few exceptions which we find to this statement are confined to the White French variety. If we had dug the whole of the rows, and selected all of the beets weighing upwards of two pounds, we would have gotten at least two thirds of the sample from the east half of the patch, and if we had, in the same manner, collected a sample of beets weighing less than one pound, we would have gotten more than half of it from the west end, and these samples would not give us the data to judge of the relation of size to percentage of sugar. It would be, in a considerable degree at least, equivalent to comparing the large beets grown in the one half with the small beets grown in the other half, which conceals the relation between the size of the beet and its percentage of sugar.

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If from the preceding table we take the average of all the samples in which the individual beets exceed two pounds, and compare it with the average of all those in which the beets weighed less than one pound, we find a difference of 1.5 per cent. sugar in favor of the small beets, which is actually a greater difference than is shown between the largest and smallest beets in any single experiment in the series. In order to make this comparison, we must take beets grown side by side, which we have endeavored to do, finding as the result of the eight experiments recorded in the last table, that beets weighing about one half pound contained, as compared with beets weigbing upwards of two pounds, in one case more than 1 per cent. more sugar, in two cases more sugar by 0.67 per cent., in one case more by 0.19 per cent., and in one case less by 0.19 per cent. Of four varieties experimented with, the maximum difference shown by three of them in favor of the small beets is 0.67 per cent., while the fourth shows a difference of a little more than 1 per cent.

§ 49. The second table given under this subject, being the results obtained from an experiment with beets of very large size, and grown at or near the edge of the patch, with a constant and abundant water supply, suggested an explanation for the general impression that large beets are poor beets. Excessively large sugar beets, 8 to 10 pounds or upwards, are unusual. Such beets are grown under such conditions as above given, at the edge of a patch with abundant water and plant food, or where they stand alone. I have analyzed Kleinwanzlebener beets grown in this manner that were very poor, showing less than half as much sugar as the average of the patch. In other words, very large size and low quality are associated with an almost unlimited feeding ground and abundance of water. There was a single row of beets on the Farm which had practically been grown under these conditions, except that the beets were thick in the row. There were three varieties: Vilmorin, White French and White Imperial. Samples of each of the varieties were taken by digging a piece of the row and sorting the beets into different lots, according to size.

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TABLE VII.—EFFECTS OF EXCESSIVE FEEDING GROUND ON QUALITY OF BEETS.

VARIETY.	Number of Beets.	Average Weight of Beets in Pounds.	Percentage of Sugar in Beets.	Coefficient of Purity.	Percentage of Sugar in Beets Grown in Patch. Rows 18 inches, Beets 8 inches.	Coefficient of Purity.
Vilmorin	6	2.02	12.78	75.5	.....	....
	9	0.50	14.30	80.0	13.97	79.2
White French	9	1.95	11.50	73.0	.....	....
	12	0.33	11.82	72.2	13.16	80.3
White Imperial	10	1.56	10.81	68.5	.....	....
	3	0.84	11.50	74.2	.....	....
	13	0.17	10.59	70.7	11.88	70.9

§ 50. This exhibits the effect of growing free, which would probably have been more pronounced. had the beets not been so crowded in the row. The Vilmorins averaged one beet to each 3.4 inches, the White French one to each 3.5 inches, and the White Imperial one to each 2.4 inches. This made the beets so thick that they pressed one another outward from the row, and modified the effect of the row being single and with an excess of room laterally. In the case of the Vilmorin there is a decided superiority shown by the small beets in both percentage of sugar and coefficient of purity, 1.5 per cent. in sugar and 4.5 in purity. The other two are so close that it is not decisive. The average of the Vilmorin is so close to the value found for the sample taken from the patch that it is not clear that the difference is due to the amount of space at the disposal of the beets. In the other two, however, there is a difference of one and one and a half per cent., respectively, in favor of the beets grown in the patch. The two soils in which these samples were grown are equally good, so far as one can judge.

§ 51. My conclusion is that in the case of beets growing side by side, those ranging in weight from one to two pounds are richer in sugar, and of higher purity, than either the larger or smaller, and of the latter that there is a slight difference in percentage of sugar in favor of the smaller beets. But the difference in purity is slightly in favor of the larger beets, and in neither case is the difference great or constant. But large beets, grown under conditions differing from those under which the smaller beets have been grown, cannot be compared with the smaller ones. I also take it, as indicated by the values obtained from the samples from our

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single row, that two great a width between the rows tends to have the same effect as permitting the beets to grow singly.

EFFECTS OF OVER IRRIGATION.

§ 52. The difference in the size of the beets, it being smaller, and their sugar content, it being higher, in the west end of one of our patches than in the east end, seemed difficult to explain, as the patch was only 400 feet long, and the soil seems equally good throughout. Our field notes, however, call attention to the fact that the west end is hard and the foliage is yellow, as though water had stood there, puddled the ground and produced the yellowness of the leaves. As this was the only perceptible difference in the conditions at the east and west ends, there remained nothing else to which to attribute the difference in the quality of the beets. There was another patch on the Farm in which this had happened, and we collected samples from this patch also and analyzed them, together with samples taken from the same patch, but which had not suffered from this cause. It appears from the table on page 27 that the average of all the samples taken from the west end exceeds by 0.71 per cent. that of all the samples from the east end. An examination of the table in detail shows how constantly the samples from the west end were better than those from the east end, though the average difference is only 0.71 per cent. The samples obtained from the other patch, consisting of eight beets each, the one yellow from the effects of too much water, the other taken a few feet away but green and healthy looking. The beets of both samples were small. In the green sample they averaged 0.62 pound. This sample showed 13.78 per cent. sugar and 79.1 purity. In the over irrigated sample the average weight was 0.66 pound. This sample showed the presence of 17.20 per cent. sugar and 89.1 coefficient of purity. It was at this time so late in the season that we could not follow this subject, and postponed further observations until the next season, 1899. I was, in a certain sense, thwarted in this part of my work; but in another sense I was not. In making an experiment with irrigating water I had an opportunity to over irrigate my beet plot and subject it to a treatment reproducing the conditions of these over-irrigated patches.

§ 53. My plot did not need water, but wishing to make observations on the changes in the amount of solids, etc., which go into solution and pass into the ground water, I obtained, through the kindness of Capt. Hawley, our Water Commissioner, enough water to thoroughly soak the ground, raising the water plane quite to the surface. This irrigation was made August 31 to September 2 inclusive. The ground was not disturbed, but allowed to settle and become hard. The beets were left to themselves until dug. The ground did become hard, and the beets showed the effect of

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over irrigation by turning yellow in places. The average for this plot in 1898 was 13.65, and the average for all samples analyzed at the Station that season was 13.62 per cent. The average for this crop, 1899, which was over-irrigated in early September, was 14.69 per cent. I have no way of judging whether I diminished the yield by treating the crop as I did, but it was the largest yield that I have yet gotten off of this ground. The size of the beets in the over-irrigated patches of the season of '98 give contradictory indications. It seems probable that the yield would be diminished, but it certainly was not materially affected in any of the observed cases.

§ 54. These facts seen to contradict the generally accepted view that a rainfall in the latter part of September or early October may effect the beets unfavorably. I recorded, in 1897, the effect of a rainfall of about .75 of an inch as depressing the sugar content to an extent which the beets did not overcome for three weeks. I think that the explanation is not difficult. A moderate rainfall may do one of two things, according to the condition of the crop at the time of its fall. If the crop is growing slowly, but has not begun its rest period, the rain may very materially increase its rate of growth, and an increase in weight of crop may take place more rapidly than the formation of sugar. This would produce a depression in the percentage of sugar present, but the percentage might be subsequently regained or exceeded. If the crop had already begun its resting period, had begun to ripen, the rain might, as it often does, produce a new growth, that is, a second growth, in which new leaves are produced, a fact familiar to every one. In this case there is a real diminution of the sugar present, and not only an apparent one due to a disproportionately large increase in the weight of the crop. In the over irrigation we have neither of these cases. On the contrary, the effort was to keep the beets growing steadily, but to puddle the soil tightly about them at a period not too much in advance of their normal time of maturing and then to leave them. I do not believe that the same results would follow in all soils, nor if the excessive irrigation should be applied at a time when it would cause the crop to take on a new growth, but there does seem to be enough promise in it to justify a sufficiently extensive series of experiments to determine the exact conditions of soil and time when it will produce advantageous results, as there is no doubt but that such conditions exist.

BEET ASH AND ITS COMPOSITION.

§ 55. In 1897 I endeavored to determine the ash at different periods in the development of the beet, and the effect of the different soil conditions upon the composition of the ash. There was a series of analyses of beet ashes, seventeen in number, made during the

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season. Thirteen of these ashes represented varieties of sugar beets, mostly the Kleinwanzlebener variety. The reason that my work was confined to this one variety was that the results obtained showed so little variation that the information to be obtained did not promise to be commensurate with the labor involved. Our conclusion from that series of analyses was, that probably owing to the richness of the soil in the elements of plant food necessary for the beet, the alkali present had exerted but little or no influence on the composition of the ash. The ash in that series which showed the largest amount of soda was one prepared from beets grown on a Farm plot free from alkali, or as much so as any of our soils. The only thing which we observed in the analyses which might be taken as indicating anything characteristic of the soil, was the tendency shown toward a high chlorin percentage. We have not endeavored to study this subject in such detail in the subsequent years, but have reduced the number of samples, enlarging them at the same time, so as to make them thoroughly representative. As we had selected the Kleinwanzlebener variety in 1897, we selected it also in 1898. The samples were not only of the same variety, but were grown on the same ground, so the ashes ought to give us a measure of the influence of the manure applied, and the effect of the cultivation if the composition of the ash is materially affected by these factors. Our conclusion in 1897 in regard to this point, was that the composition of beet ashes was relatively constant, within comparatively narrow limits. The following analyses corroborate this view, though they are not given for this purpose:

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TABLE VIII.—GIVING COMPOSITION OF ASHES OF BEETS GROWN WITH AND WITHOUT MANURE.

	Kleinwanzlebener. Chemical Plot. Manured. 1898.	Kleinwanzlebener. Chemical Plot. Not Manured. 1898.	Kleinwanzlebener. Chemical Plot. Not Manured. 1897.	Vilmorin Improved. Farm Plot. Not Manured. 1898.	Vilmorin. Farm Plot. Not Manured. 1897.	Vilmorin. Chemical Plot. Not Manured. 1899.	Zehringen. Chemical Plot. Not Manured. 1899.
Dry Matter in Beets	19.770	20.822	18.090	23.704	17.500	23.493	24.423
Ash in Dry Matter	5.650	5.433	6.491	5.476	5.469	4.000	4.500
Insoluble Ash	1.075	0.921	1.389	0.850	1.311	1.350	1.150
Soluble Ash	4.575	4.512	5.102	4.626	4.158	2.650	3.350
Ash in Fresh Sample	1.117	1.131	1.174	1.298	0.957	0.940	1.099
Carbon	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.	Trace.
Sand	1.440	1.079	1.188	1.125	0.931	2.613	2.139
Silica	0.946	0.887	1.102	0.652	1.264	1.373	1.234
Sulphuric Acid	2.760	3.062	3.476	3.364	2.878	3.747	3.913
Phosphoric Acid	9.984	8.484	8.668	6.923	6.088	8.613	9.109
Carbonic Acid	18.106	17.092	15.690	22.300	19.177	16.890	15.294
Chlorin	10.752	11.857	13.599	6.966	10.887	5.699	9.464
Potassic Oxid	40.061	37.923	42.976	38.322	40.065	40.525	38.572
Sodic Oxid	8.699	12.184	8.811	12.736	11.161	5.878	9.219
Calcic Oxid	2.549	2.612	1.951	2.356	3.409	4.106	2.980
Magnesic Oxid	5.745	5.366	5.573	5.156	5.264	7.226	7.242
Ferric Oxid	0.373	0.306	0.146	0.238	0.414	0.396	0.707
Aluminic Oxid	0.087	0.308	0.538	0.100	0.774	0.184	0.193
Manganic Oxid	0.195	0.331	0.195	0.152	0.186	0.310	0.204
Loss on Ignition	1.519	1.626	.....	1.532	.....	3.454	2.308
Sum	103.109	103.062	102.912	101.922	102.498	101.014	102.498
Oxygen Equivalent to Chlorin	2.423	2.672	2.889	1.570	2.441	1.284	2.132
Total	100.686	100.390	100.073	100.352	100.057	99.730	100.366

§ 56. This table shows the composition of beet ashes obtained from beets grown on three different soils and under different conditions, both of season and cultivation. The differences in the percentage of dry matter in these samples are, as I have already suggested, to be attributed to seasonal influences rather than to differences due to variety and cultivation. But whether the other differences, such as is observed, for example, in the percentage of the phosphoric acid, is to be attributed to the differences in the soils, season or cultivation, appears open to doubt, though the

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higher percentage of this acid in the ash of beets grown on the manured ground indicates that the cultivation has an influence upon the amount of this component of the ash, tending to increase it. On page 48, Bulletin 46, is given an analysis of the ash of a sample of Kleinwanzlebener beets grown in New Mexico, in which we have less than 4 per cent. (3 336 per cent.) of phosphoric acid, showing that ash from the same variety may have a varying composition, due to differences of soil, and it may be that the lower phosphoric acid in the Vilmorin ashes, given in the table, is due to this. and not to variety, for these samples were grown on different plots in 1897 and 1898, while the Kleinwanzlebener samples were grown on the same plot, one half of which, however, had received a dressing of manure. The percentage of chlorin shows the greatest change as a result of the cultivation and continued cropping. In 1897 the ash of the Kleinwanzlebener beets contained 12.599 per cent. of chlorin; in 1898. grown on the portion which had not been manured, the ash contained 11.857 per cent., and the ash of the beets grown on the manured portion contained 10.752 per cent. The highest percentage of chlorin found in the ashes of the Zehringen variety, in 1899, was 9.464 per cent., while the Kleinwanzlebeners showed only 5.699 per cent. chlorin present in the ash. These last two samples were grown on soil which had not at any time received a dressing of manure. These percentages indicate a decrease in the amount of chlorin taken up by the beets, as the soil conditions are improved. There has been, at the same time, an improvement in the quality of the beets. In 1897 the Kleinwanzlebener variety showed 11.76 per cent. sugar, 76.0 purity; in 1898, 13.97 per cent. sugar, 84.6 purity; in 1899, 15.34 per cent. sugar, 80.8 purity. For two years, 1897 and 1898, the percentages of sulphuric acid, phosphoric acid, lime and magnesia remained almost the same. In 1899, however, the percentages of lime and magnesia increased by about 1 per cent. in each case. Previous to 1899, the highest percentage found for the magnesia was 5.74 per cent., but in 1899 it reached 7.25 per cent., an increase of 1.5 per cent. In the case of the lime, the highest percentage found, in 1897 and 1898, was 2.826 per cent.; in 1899, 4.106 per cent.; also an increase of nearly 1.5 per cent. These samples were grown on the same plots, and were of the same variety of beets. The changes observed are toward a closer agreement with other analyses than heretofore. These percentages do not establish permanent changes, but do show the tendency which the continued cropping and cultivation of this soil has to modify its effects upon the mineral matters taken up by the plants. The tables giving the percentage of sugar and the coefficient of purity for these crops show a decided improvement in the three years covered by the experiments, and the analyses of the ashes show the tendency which manuring,

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cultivation and continued cropping to the same crop, has to ameliorate the effects of unfavorable soil conditions.

§ 57. Reference was made to the question as whether the manure added to the soil, acted, in this case, as a fertilizer or as a mechanical agent, simply improving the physical condition of the soil. The composition of the ash shows that its action is not merely physical but is well marked chemically, in that the percentage of chlorin is lowered and that of phosphoric acid is increased.

§ 58. Reference to the Tables Nos. I. and II., showing the percentage of sugar, etc., for the years 1898 and 1899, will show that the effect of the manure upon the sugar content and coefficient of purity was not marked until the end of the season, or the period of ripening. This was especially true in 1898; the difference in favor of the not manured plots being greater in 1899 than in 1898. It should, however, be borne in mind that all of the beets in '99 are remarkably high in sugar, and quite up to the average in purity, and while the beets grown on the plots having received no manure were better than those grown on plots which had received manure, it is not to be inferred that the latter were poor beets in regard to either sugar content or purity, for the averages for the two varieties grown on the manured plots in 1899 were 15.06 per cent. sugar, 81.7 purity, and 14.15 per cent. sugar, 77.7 purity, while those grown without manure showed 15.34 per cent. sugar, 80.8 purity, and 16.24 per cent. sugar and 84.5 purity.

The effects of the straw were probably almost wholly mechanical, and this effect was very evident. The effect of the sheep manure was evident in the improvement of the physical condition of the soil, in the germination of the seed, the more vigorous growth of the crop, the shape of the beets, the sugar content of the beets, the coefficient of purity, and in its effects upon the composition of the ash.

§ 59. The effects of the manure upon the vigor of the growth, the percentage of sugar and the coefficient of purity were quite as marked in the second as in the first crop grown on the soil after the application of the manure. The manure being more thoroughly incorporated with the soil the second year, did not produce as marked effects upon the shape of the beets as it did the first year.

COMPOSITION OF THE MANURE APPLIED.

§ 60. It has already been stated that the amount of manure applied was at the rate of sixty-four tons to the acre, also that it was applied broadcast in February and plowed under in May. At the time of the application of the manure, my opinion was that this soil was so abundantly rich in plant food that the only effect of the manure would be mechanical. The results observed show that

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its effects were varied, and it apparently produced important chemical changes in the soil, because of its fertilizing ingredients.

§ 61. This manure contained, at the time of its application, 45.14 per cent. of dry matter, or 28.89 tons of dry matter was applied per acre.

§ 62. The ammonia in the fresh manure was equal to 0.926 per cent. of nitrogen. This determination was made by distillation with magnesic oxid, to learn how much of the total nitrogen existed in the manure in the form of ammonia and ammonia salts; also to learn how great a loss might be suffered by the volatilization of this compound under the influence of our winds and sunshine. The loss in our particular case was probably large, as the weather remained clear for some time after the application of the manure, and dried it out until it became very dry. The percentage of the total nitrogen, which was set free as ammonia by the magnesic oxid, was 47.22 per cent., and the amount expelled by drying the manure to a constant weight in a water oven was 60.73 per cent. of the total. I do not know the power of this soil to absorb the ammonia which was ready formed in the manure, but it is evident that the danger of loss was, under the conditions given, greater than one would expect. Had rain fallen immediately after the application, the loss would have been much smaller than it probably was.

§ 63. The total nitrogen present in the manure was 1.940 per cent., or the nitrogen applied was at the rate of 2,483.2 pounds per acre; or if we allow a loss of one fourth of the nitrogen, due to volatilization and failure of the soil to absorb the ammonia, there would remain 1,861.6 pounds to the acre. The phosphoric acid in the fresh manure was 0.654 per cent., or an application of 837.1 pounds, equivalent to 1,573.4 pounds of calcic hydric phosphate per acre.

§ 64. The potassic oxid equaled 2.427 per cent of the fresh manure, or a dressing of 4,077.36 pounds of potassic oxid to the acre, equivalent to 8,543.11 pounds of potassic sulphate. We have the application of 2,483.2 pounds of nitrogen, 1,573.4 pounds of calcic hydric phosphate and 8,543.1 pounds of potassic sulphate, or their equivalent, together with nearly 25 tons of organic matter, producing the effects recorded in the preceding pages.

§ 65. The most salient question suggested by a comparison of the composition of the manure applied and the results produced, is in regard to the phosphoric acid and potassic oxid, the former being materially increased in the ash of the beets, while the latter, on the contrary, is not effected, or is possibly decreased. The amount of potassic oxid applied is greatly in excess of the phosphoric acid, and the ratio of the potassic salts to the phosphates in the manure is

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greater than the ratio of potash to phosphoric acid in the ash. The effect of the manure is probably to be found in the specific action of the nitrogen and the organic matter. I think that the analyses of the soil will tend to establish this view.

§ 66. The nitric acid in the ground water in 1898 is more variable and much higher than it was in 1897, but on the other hand, the water level stood somewhat higher in 1897 than it did in 1898, the difference being about one foot. I think that the smaller quantity of water applied to the surface in 1898, either as irrigation water or as rain, tending perhaps to yield a more concentrated percolate, will not account for the greatly increased amount of nitric acid in the ground water, but that it is to be explained chiefly by the oxidation of the nitrogen added to the soil in the manure.

§ 67. The total solids in the ground water in 1898 were higher, as a rule, than in 1897, but whether they were as much higher as the supply of water was less, I cannot say. I know that it does not hold good that the total solids in the water are larger in amount as the water is lower. The greater the depth of soil the water has to travel through, the less likely we are to find excessively large amounts of the total solids in the water.

§ 68. In 1899 we had a larger amount of water as sub-irrigation water, and it may be doubted whether the total solids contained in the ground water should be used as a criterion of the effect of the manure, *i. e.*, as a measure of the chemical changes induced by the manure. I regret that the relation here is so obscure and involved that it lessens the value of the results obtained, but our observations show that the total solids fell again in 1899 to a lower point than they showed in 1897.

Irrigation or heavy rains which fill the soil with water, raise the water level, and cause an increase in the chlorin contained in the ground water. The manure applied seemed to make the increase more pronounced and of greater duration.

The analyses of the ground water in 1898 do not show a sufficiently marked difference to justify any further inferences than those based upon the nitric acid and chlorin. We shall discuss this part of our work more fully in the succeeding part of our study.

§ 69. The effects upon the crop indicate that the manure applied produced not only mechanical effects upon our soil, but also chemical effects, both tending to improve its condition and eliminate the effect of the alkali in increasing the percentage of ash. But it is not clear what relation exists between the composition of the manure and the general effects produced. The observations made upon the effects of the straw, and the increased amount of nitric acid in the water (it is understood that this nitric acid is present in

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the form of nitrates), incline me to the view that the organic matter, including the nitrogen, played an important part in our particular case.

SOAKING EXPERIMENTS.

§ 70. It is a universally acknowledged fact that the maturing of the beet is accompanied by an increase in the coefficient of purity; that is, that the sugar in the juice of ripe beets constitutes a larger percentage of the total solids than it does in the juice of green beets. The percentage of sugar in the ripe beet is also higher than in the same beet when it is green. The increase in the ratio of the sugar to the solids not sugar, might be due to an increase in the amount of sugar, without any change in the amount of the other solids, in which case there would be an increase in the weight of the beets, corresponding to the increase in the amount of sugar and of the dry matter in the beet. There is, however, a disappearance of solids not sugar at this period, which indicates that the percentage of total solids in the beet is not maintained at an approximately constant figure by a proportional increase of crop and sugar content, but a proportional decrease of the one and increase of the other.

§ 71. The following experiments were made in an endeavor to obtain more definite information on this subject, *i. e.*, whether this change of material into sugar may continue after the beet has been pulled; for if we can prove an increase in the amount of sugar, before and after soaking, the probability of such a change in the living beet is strengthened. In 1897 we found that there was a period during which sugar was rapidly formed, but that sugar was present early in the history of the crop, and that there was a slow increase, after the growing season for the crop had passed, even extending up to the early part of January, the beets having been left in the ground and covered with straw.

In 1898 a different experiment was performed. Four varieties of beets were chosen, Vilmorin Improved, White Imperial, White French and Kleinwanzlebener. Sixty-eight beets of the first and sixty of each of the last three varieties were taken, and after washing were paired, according to size, and one of each pair taken for immediate analysis, while the other was taken for soaking. The halves of the samples obtained in this manner varied but little from one another, the maximum difference being six pounds on a sample weighing 132 pounds. One half was analyzed immediately, the other half was packed in galvanized iron tubs, with fine sand, in such manner that the beets did not touch one another; water was added till the tubs were full, and pieces of ice were placed on top of them. The samples were soaked in this manner for seven days. The temperature of the water in the interior of the sand ranged from 41° to 48° F. throughout this time. The results were as follows:

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TABLE IX.—SHOWING THE EFFECTS OF SOAKING BEETS ON THE SUGAR CONTENT.

Year.	Variety.	Before Soaking.				After Soaking.	
		Number of Beets in Sample.	Weight of Beets in Pounds.	Pounds of Sugar.	Purity.	Pounds of Sugar.	Coefficient of Purity.
1898	Vilmorin Improved	34	65.00	8.2435	76.5	9.7657	78.8
	White Imperial	30	59.50	6.8960	74.0	7.0420	74.4
	White French	30	67.40	8.8698	80.3	8.8797	86.1
	Kleinwanzlebener	30	24.70	3.3789	77.0	3.5644	83.5
1899	Zehringen	30	35.12	5.2020	78.7	5.6451	84.4
	Zehringen	15	18.48	2.5918	77.2	2.7628	83.8
	Vilmorin	30	42.20	6.6549	82.0	6.8959	82.7
	Vilmorin	15	19.25	3.0560	84.2	3.1086	82.5
	Average			5.6115	78.7	5.9580	82.0

§ 72. The samples taken were large enough to eliminate the errors in sampling, any effects of size of beets, and also any effects which might be attributed to variety. The same experiment was repeated twice in 1899, using two varieties. The series of experiments is wholly consistent in showing an increase in the amount of sugar after the seven days' soaking. I regret that I have not tried this experiment with beets at different periods of their growth. The experiments recorded were all made with mature beets, and the formation of sugar was going on slowly and would probably have proceeded slowly if the beets had remained in the ground with their full growth of leaves intact.

§ 73. The effect upon the coefficient of purity is quite as marked as upon the amount of sugar present. In one case, it is true, the coefficient of purity appears to have been lowered; this may really be the case, but I am inclined to consider it an accident, especially as the seven other experiments agree in showing an increase in the coefficient, while this one alone shows a decrease.

THE REDUCING POWER OF BEET CHIPS.

§ 74. Thinking that some light might be obtained on the preceding subject by determining the reducing power, shown by the beet pulp after the extraction of the sugars, reacting with alpha naphtol, by means of 80 per cent. alcohol, a series of experiments was made, in which the ground dried beets were extracted with

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boiling 80 per cent. alcohol so long as the solution continued to react with alpha naphtol. I will observe, in passing, that this alcoholic extract yielded, after the alcohol had been distilled off, furfurol, upon distillation with hydrochloric acid of 1.06 sp. gr. The residue thus freed from sugar was boiled for thirty minutes in a flask provided with a reflux condenser, with 1.25 per cent. hydrochloric acid solution. The solution was made to volum, and its reducing power determined. No furfurol could be detected as escaping from the condenser. The results were as follows:

Kleinwanzlebener	9- 2-97—2.535 per cent. pentoses.
Kleinwanzlebener	9-22-97—3.415 per cent. pentoses.
Kleinwanzlebener	10-13-97—2.624 per cent. pentoses.
Vilmorin	10-13-97—3.445 per cent. pentoses.
Yellow Globe	10-29-97—2.673 per cent. pentoses.
Lane's Imperial	10-29-97—2.729 per cent. pentoses.
Zehringen	11-10-99—5.897 per cent. pentoses.
Vilmorin	11-10-99—5.615 per cent. pentoses.
Zehringen—after soaking	11-10-99—5.770 per cent. pentoses.
Vilmorin—after soaking	11-10-99—5.065 per cent. pentoses.

The total furfurol which the samples were capable of yielding was not determined.

§ 75. The two fodder beets, the Yellow Globe and the Lane's Imperial, were included to see whether they contained more or less of these pentose bodies than the sugar beets. In the Zehringen and Vilmorin samples of 1899, we observe that the reducing power of the extracted pulp is high. The sugar content is also high, but the table does not show a decrease in these substances as the beet matures; at best, it is not conclusive, because the series is not extended enough. But three out of four show a lower percentage for pentoses, accompanying a lower sugar percentage, and four out of five show a higher percentage, accompanying the higher sugar percentage. The two soaked samples agree in showing a decrease in the pentoses present, which may be due to transformation of these bodies into others. It seems probable that not only the monosaccharids, such as glucose, may suffer change into polysaccharids, but that the pentoses may also be involved in similar changes.

THE SUGARS IN BEET LEAVES.

§ 76. I have tried four methods in my efforts to prove the presence of sucrose in the leaves and to determine its quantity.

The first one tried was the investigation of the expressed juice of the leaves. This was very unsatisfactory, and led to no conclusion except that there is in the juice of the leaves one or more bodies which yield upon hydrolysis with hydrochloric acid bodies which reduce Fehling's solution, but I did not succeed in establishing the presence of sucrose by this method.

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§ 77. The expressed juice of the leaves was subjected to fermentation and subsequent distillation. Two thousand seven hundred and forty-nine grams of juice, expressed from fresh leaves, stems and blades being used, received a quantity of compressed yeast and was allowed to stand 36 hours at a temperature of from 26° to 31° C., after which it was subjected to distillation. A blank test was made as a control. The results showed the probability of fermentable sugars in very small quantities in the juice of the leaves.

§ 78. A larger quantity, 30 pounds, of stems of leaves were gathered October 20, 1899, when the deposition of sugar was supposed to be active, dried quickly, ground, and subsequently extracted with 80 per cent. alcohol. The alcohol was distilled off and the extract concentrated, a little ammonia being added from time to time. The fluid extract was treated repeatedly with ether to remove the chlorophyll, etc.; an aliquot part of it was taken and treated with lead acetate, the sugars inverted by hydrochloric acid, determined by Fehling's solution and calculated as sucrose. The total sugars found corresponded to 0.28 per cent. calculated on the green stems. The inversion was quite difficult to effect, much more so than the inversion of pure solutions of cane sugar.

§ 79. The fourth method followed was that of Brown and Morris, *i. e.*, extraction with ether, and solution of sugars in alcohol; treatment with lead acetate, removal of lead; determination of glucose by means of Fehling's solution; inversion of maltose by means of invertin, and inversion of all of the invertible sugars by hydrochloric acid.

§ 80. A sample of leaves, Kleinwanzlebener variety, gathered September 2, 9 a. m., when the beets were growing vigorously, gave the following results:

Glucose	0.156 per cent.
Maltose	0.030 per cent.
Sucrose	0.000 per cent.
Total	0.186 per cent.

Kleinwanzlebener, leaves gathered September 22, 9 a. m.:

Glucose	0.801 per cent.
Maltose	0.023 per cent.
Sucrose	0.064 per cent.
Total	0.888 per cent.

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Kleinwanzlebener, leaves gathered October 13, 10 a. m.:

Glucose	0.398 per cent.
Maltose	0.394 per cent.
Sucrose	Lost per cent.
Total	0.792 per cent.

Vilmorin, leaves gathered October 13, 10 a. m.:

Glucose	0.398 per cent.
Maltose	0.186 per cent.
Sucrose	0.000 per cent.
Total	0.436 per cent.

These results agree in showing the presence of glucose and maltose, the latter being present in smaller quantity than the glucose, while cane sugar is present in subordinate quantities or absent.

As experiments show that the alcoholic extract of beet leaves yields furfurol when distilled with hydrochloric acid, indicating the presence of pentoses in this extract, which are susceptible of hydrolysis, it cannot be considered as rigorously proven that there is any cane sugar present, though the probability of its presence seems quite strong. But it is much less than has been found in the leaves of other plants which do not store sugar as a supply for the future use of the plant.

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SUMMARY.

§ 81. The effect of the alkali is noticeable, but to a less extent than in 1897, and the area in which its effects appear are more restricted.

The application of straw, as well as of manure, improved the condition of the ground and perceptibly mitigated the effects of the alkali.

The application of manure improved the stand of beets, but did not prevent a failure to germinate in some spots.

The amount of water received by the crop of 1898, rain and irrigation water together, was about eight inches.

The water plane varied from three to six feet below the surface in different portions of the patch at various times during the season.

The force of capillarity caused water to rise 45 inches as a maximum, the surface of the soil being protected from wind and sun.

The plot receives subirrigation, though there is a drain and an open ditch, supposed to intercept this water.

The cultivation in 1897 differed in one respect from that given in 1898 and 1899. In 1897 the crop received two irrigations and more cultivations than in the latter years. The soil was kept more mellow. In 1899 it was purposely firmed about the beets in September, and no effort was made to mellow it after this. The percentage of sugar in 1898 and 1899 was higher than in 1897. This was in part caused by the condition of the soil produced in 1899 by intentional over-irrigation.

The effects of the manure upon the crop was to produce ill shaped, rooty beets, also to slightly lower the percentage of sugar and the coefficient of purity. Its effect on the shape of the beets was far more serious than that on the percentage of sugar and coefficient of purity.

The conclusion reached in 1897, relative to the effect of the alkalized condition of the soil upon the percentage of sugar in the

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crop, is corroborated by the observations of the years 1898 and 1899, *i. e.*, that the alkali *per se* is not injurious in such quantities as it is present in any part of our plot.

The effect of the manure upon the shape of the beets was noticeable the second season after its application, but it was less marked than it was the first season. But its effect upon the percentage of sugar and the coefficient of purity was almost as marked the second year after its application as it was the first year. The peculiar soil conditions are in part the cause of this, for they retard the rotting and complete incorporation of the manure with the soil.

The marked increase in the percentage of sugar at the period of ripening, observed in 1897, was not observed in the years 1898 and 1899. The difference in the manner of maturing is attributed to the difference in the seasons. It is possible, though not probable, that such increase had already taken place before we took our first samples, September 27. The beets did not show any signs of having ripened at this time.

The beets from the Farm plots and our alkali ground showed no difference in this respect, corroborating the observation of 1897, that the alkali was without influence on the maturing of the beet.

Cut straw was applied to one section in order to compare its effects with those of the manure, as a measure of the extent to which the manure might act as a mechanical agent. It benefited the soil greatly, its mechanical effect being nearly as great as that of the manure, but the effects of the manure were in other respects much greater.

The percentage of dry matter in the beets of the years 1898 and 1899 was higher than in 1897, due, probably, to seasonal differences. The average difference for beets from my plot was 4.9 per cent. in 1898 and 3.8 per cent. in 1899.

The average percentage of sugar in the crop for 1898 was, after making allowance for some drying out of the samples, 13.62 per cent. The average of the crop grown on alkali soil was 13.65 per cent.

Medium sized beets are apt to be better than either large or small beets, but the size is less determinative of the quality of the beets than the conditions under which they grow. Beets weighing two pounds and upwards are quite as rich as those weighing less than one pound, if they have been grown under the same conditions.

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The effect of excessive free space was studied on a row planted singly, with unoccupied ground for several feet on either side. The beets were very close to one another in the row. The average percentage of sugar was lower than shown by the same varieties grown in rows twenty inches apart.

Over irrigation applied at the proper time, produces, in some soils, an increase in the percentage of sugar, without materially, if at all, decreasing the crop.

The continued cropping and cultivation of our plot has slightly decreased the percentage of ash in the beet and changed its composition, particularly lowering the percentage of chlorin.

If fresh beets be soaked for seven days in water cooled by ice, an actual increase of sugar takes place, indicating the formation of sugar in the beet root.

The substances in beet chips hydrolized by dilute hydrochloric acid, are, as a rule, higher in beets rich in sugar than in stock beets, or in those having a lower percentage of sugar.

The leaves of the sugar beet contain some glucose and maltose, but only small quantities, if any, sucrose.

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Bulletin 59. **December, 1900.**

The Agricultural Experiment Station

OF THE

Agricultural College of Colorado.

INVESTIGATION OF THE GREAT PLAINS.

FIELD NOTES

—FROM—

TRIPS IN EASTERN COLORADO.

—BY—

J. E. PAYNE.

PUBLISHED BY THE EXPERIMENT STATION
Fort Collins, Colorado.
1900.

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FORT COLLINS, COLORADO.

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* Died December 9, 1900.

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A VARIETY TEST AND GENERAL REMARKS

—ON—

BUSH FRUITS.

CARL H. POTTER.

GENERAL REMARKS.

It is not the intention in issuing the present bulletin to go deeply into a consideration of the culture and general management of bush-fruit plantations. This information comes to the practical growers from many sources.

Good and abundant cultivation and irrigation is of prime importance. A naturally cool and somewhat moist soil is desirable, and in the hotter portions of the State a partial shade is often necessary. This shade is sometimes obtained by planting the bushes near shade trees, or even in orchards, but this latter practice is not always looked upon with favor by our best orchardists. Again, simple mulching is used.

The rows should be placed at a liberal distance apart and the hills should not be crowded in the rows. A few good, vigorous shoots should be grown, thus better to resist the ravages of the increasing number of our insect and disease enemies.

Prof. Gillette, in Bulletin No. 47 of this station, names five or six insect enemies which are injurious to our bush fruits. Of these, perhaps the worst two are the currant-borer, *Sesia tipuliformis*, and the saw-fly, *Pristophora grossulariæ*. The former is easily removed and destroyed by the usual annual pruning, thinning and burning of the old canes. The larvæ of the saw-fly are easily destroyed by the common arsenical sprays.

The ravages of the fruit-worm will be spoken of in connection with the fruits injured.

Diseases of the plants have but recently become of economic importance on our grounds. They will furnish material for future study and publication.

Our present plantations of bush fruits contain about

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seventy varieties. A few varieties disappeared from the test-plats during the last three years, other varieties planted failed to become established, and still others were planted only last spring.

The older plantation was set in 1896. Other plants and other varieties were added in 1897 and in 1898, and a new plantation set in 1900. In so far as the blackberries and raspberries are concerned, these latter years enter comparatively little into the description or tests of plants or fruit which follow. The season of 1898 was so extremely dry that the water for irrigation purposes was entirely inadequate to the development of either fruit or vine.

This season of drought was followed by the extremely early and severe winter of 1898-9 which prevented the proper covering of the vines, resulting in the complete killing to the ground of all the raspberry and blackberry canes, thus preventing a crop in 1899.

The canes of all the raspberry and blackberry vines were pinched back when about 18 inches in height, the result being a fine growth of well-matured stocky canes. They were laid down by removing the earth from underneath one side of the hill and forcing the tops in that direction with a fork, then covering to a depth of about 3 inches with earth. By a yearly practice of this method the roots extend laterally and are but little injured in the process of laying down, while the canes, though stiff and stout, are but little bent and are therefore uninjured.

Winter protection is the only safe course to follow in this section of the state.

GOOSEBERRIES--*Ribes*.

Even some of the currants and gooseberries suffered more or less severely by the extreme winter of 1898-9. A record of this injury follows in the notes on the individual varieties.

The gooseberry plantation consisted of six varieties, one of which, Industry, is now extinct. As there has been such a great difference in the age and vigor of the several varieties, it is thought best for the present not to append figures giving the comparative yields.

Three varieties new to the plantation were added last spring.

The gooseberry crop of 1900 was, from a commercial standpoint, almost totally destroyed by the ravages of the fruit worm, known to science as *Epochra Canadensis*. The "worms" are the larvæ of a two-winged fly which deposits

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its eggs underneath the skin of the fruit while the latter is still quite immature. Within the fruit, where they are quite safe from insecticides of all kinds, the larvæ grow to maturity. The fruit becomes worthless. The only known remedy is to destroy the fruit while it still contains the larvæ.

Following are the varieties tested:

Downing—*Ribes cynosbati.*

Some old bushes were reset in 1896 and some young ones in 1898. The bushes are upright in growth with stiff stocky branches, spines stout and prominent, berries medium to large with a conic, dark green apex, and covered with a heavy glaucous coat. Yield good. The variety was very severely killed back by the cold winter. All the hills, old and young, are looking remarkably vigorous now.

Houghton—*R. hirtellum.*

Of this variety some old bushes were reset in 1896, to which were added new bushes from the nursery the same year.

The variety is a vigorous grower with long, slender, spreading branches, spines slender, berries small to medium, surface glaucous, obconic form, deep green color, very sour, yield very good—fully a week later than the other varieties in the plat.

The old canes are fairly stocky and well loaded with fruit buds, but the variety is not nearly so strong and vigorous a grower as is Oregon Champion. Very little injured by the co'd winter.

Industry—*R. grossularia.*

Young plants of this variety were set in 1896, to which were added some old bushes reset the same spring. The variety is of European origin. The leaves are dark green, leathery, with a lustrous surface. The thorns are short and stout and frequently there is but one at the base of each leaf-stalk instead of the usual cluster of two or three. The berries are large, oval, veins conspicuous, with a considerable number of bristles on the surface. The variety entirely succumbed to the mild winters of '96-7 and '97 8.

Oregon Champion—*R. grossularia.*

New plants of this variety were set in 1896. The variety is of spreading habit with rather large, stiff and stocky branches. The leaves are somewhat more glaucous and darker green than are the leaves of other varieties. The berry is large, oval, with a glaucous surface. The variety was apparently very little injured by the excessively cold winter of '99 and bore an excellent crop of fruit the next season. It is a most desirable variety on account of the vigor of the plants and the yield of fruit.

Pearl—*R. grossularia.*

Young plants of this variety were set in the plat in 1897. They made a good healthy growth during that and the following season. The winter of 1899 killed the canes to the ground and they were cut out. The growth the past two seasons consists of many vigorous and well branched canes.

Smith's Improved—*R. grossularia.*

Old bushes of this variety were reset in 1896. The variety is fairly vigorous and was not entirely killed back by the winter of 1899. It was severely pruned and made a fair growth during the past two seasons. Berries very large—largest on the grounds—quality good to excellent; long, oval form. Translucent, with conspicuous lighter-colored veins.

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CURRANTS—*Ribes.*

The station plantation of currants consists of eighteen varieties, fifteen of which belong to the species *rubrum*, one Dubett Tree being *Ribes aurium* and two *Ribes nigrum*. The latter with four varieties of *rubrum* were set only last spring.

The red sorts are for the most part very similar, it being quite difficult to distinguish between them either by their fruit or the character of the plants. Where old bunchy varieties were set along with those trained to more of a tree form, the latter invariably produced larger fruit, but not so large a yield. The more abundant the fruit, the smaller the berries. The crop of fruit was, commercially speaking, a complete failure the past season owing to the ravages of the insect mentioned in connection with gooseberries. Much of the fruit fell before time for picking. Of that which remained on the bushes till the sound fruit was mature, from 25 to 60 per cent was stung and contained the larvæ of the fly. No such extensive damage appears on our previous records. Some plantations in this vicinity were comparatively uninjured.

The varieties of currants tested on the station grounds follow in alphabetical order:

Albert Prince.

This variety is but slightly represented in the Station plat. It is considerably lacking in vigor and has been kept closely pruned for propagation purposes. The berries are of good size, white, and sweet.

Cherry.

Both old and young plants were included in the 1896 plat, to which were added young plants in 1898. This red variety produced the largest berries of any variety on the grounds in 1896, and a good yield withal. Some of the berries measured 9-16 inches in diameter. The stems or branches are a little stronger than Fay, but not nearly so strong as Red Dutch or Victoria.

Dubett Tree—*Ribes aurium.*

One plant of this variety was set in the plat in 1897. It has made a vigorous growth, quite upright in character. Although the wood appears to ripen well, yet the leaves near the tips remain quite fresh and green till midwinter or later The variety is being propagated by cuttings and the number of plants will be increased in the near future.

So far the fruit produced has been quite insignificant.

Fay.

Both old and young plants of this variety were set in 1896. The variety is not nearly so strong and vigorous as either Victoria or Red Dutch. It produces a great many new canes of spreading and unkempt habit. The injury from the winter of '99 was considerable. Berries red, medium to large Yield fair to good.

The variety requires extra care to justify the recommendations so frequently given it.

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Holland—Long Bunch.

This old sort was not introduced to our plantation till 1897, and then by very few plants, which have since been very closely pruned for propagation purposes. The plants are fairly vigorous, berries of good size, white, and sweet.

North Star.

A few old plants were set in 1896, followed by young plants in 1897 and in 1898. This variety was somewhat injured by the winter of '99. It is strong and stocky, but not nearly so much so as is Raby Castle or Victoria. It is much like Red Dutch in size and bearing propensities but is later in ripening.

Pomona.

But a few plants of this variety were set in the Station plat in 1897 and these have been closely pruned for propagation purposes.

The variety seems to be below the standard for vigor and was very severely killed back by the cold winter. It is a red variety.

Raby Castle.

Old plants of this variety were set in the Station plat in 1896 and young plants in 1898. It is considered by Prof. Card in his handbook on "Bush Fruits" of "The Rural Science Series" to be identical with Victoria. On our ground the two have every appearance of being one and the same variety.

Red Dutch.

Both old and young plants of this variety were set in 1896. It is an old standard sort and one of the best as to bearing propensities, but the fruits are smaller than are the fruits of the more recently introduced varieties. While this variety endures neglect well, yet with good culture and pruning the berries are medium to large in size. It is much like Victoria, but taller and more slender, producing new shoots in abundance. It was apparently uninjured by the recent cold winter.

Versaillaise.

Both old and young plants of this variety were set in 1896. It is nearly as vigorous a grower as Red Dutch, but there are many more shoots which are quite unkempt in habit—much like Fay in this respect, but not so exaggerated. Injury by winter of '99 very slight. Berries are large, spherical, red, rather more acid than our other varieties.

Victoria.

This is the champion variety of the plantation. Set in 1896. Although producing no more fruit than some of the other sorts, it is very strong, vigorous, upright in character and its freedom from the production of many shoots render it a very desirable variety. The fruits are of medium size, red, mildly acid—remaining for a long time on the bushes.

White Grape.

This excellent white variety was reset and new plants added in 1896. The bushes are a little shorter and more stocky than Versaillaise with not quite so many shoots. Stems are somewhat inclined to be prostrate. Apparently uninjured by the cold winters. Berries are large, of a translucent yellowish white color, growing in long bunches, but sweeter than most red sorts—a good bearer.

Probably the best white currant on the market at the present time.

RASPBERRIES—*Rubus.*

Partial reports upon twenty-three varieties of raspberries follow. It is to be regretted that the record of fruiting

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is not more complete; but, as stated under the general head "Bush Fruits," this lack of data is principally due to the unusual climatic conditions of 1898 and 1899. Following an extremely wet April, the season of 1900 was unusually hot and dry.

While authorities differ greatly concerning the proper position or location of our various cultivated varieties of raspberries and blackberries within the genus *Rubus*, yet probably the great majority accept the classification given by the American Pomological Society. According to this, raspberries are divided into four species, the European red varieties being *Rubus idæus*, the American reds *R. strigosus*, the black-caps *R. occidentalis*, and the purple canes which are considered to be hybrid between *R. strigosus* and *R. occidentalis* with all degrees of tendency toward either parent, are classified as *R. neglectus*. The purple canes, as a class, are propagated by the tips, and very little, if any, by suckers.

Brandywine—*R. strigosus*.

This old red variety was not introduced to the Station grounds till 1898, consequently there are no adequate notes upon the fruit. The plant is stocky with large reddish colored canes which sucker freely.

Carman—*R. occidentalis*.

This excellent black-cap variety was set in the present plat in 1896. It is an extra early variety. Plants not large, but sufficiently robust. Berries medium size, mild flavor, juicy—in full bearing the latter half of July.

First ripe, July 3; last picking, August 2; full pickings, July 12-19.

Columbian—*R. neglectus*.

This is considered to be one of the leading varieties of the purple canes, being very much like the Shaffer in appearance—a very strong and vigorous grower. It is said to be a very prolific bearer, the fruit being a little later and larger than Shaffer.

Cuthbert—*R. strigosus*.

This old standby of the American red type has not yet been excelled on our grounds, although growing alongside the Marlboro. The plants in a part of one row of Cuthbert were carefully removed and Marlboro set instead, but the latter have been nearly exterminated by Cuthbert plants coming from old underground canes. Cuthbert leaves are narrower than are those of Turner, the latter being especially broad and showing much more color upon the upper surface while young than do Cuthbert leaves. Cuthbert canes have a considerable number of small prickles. Berries are large, dark crimson, broad, conic, grains small and compact. The flesh is good quality, firm, standing up well when picked in quart boxes. First picking, July 10; last, August 23; full picking, July 19 to August 5.

Golden Queen—*R. strigosus*.

This is considered to be simply a sport of Cuthbert, differing from it principally in the yellow color of its fruit.

Gregg—*R. occidentalis*.

This has long been the standard black-cap. Although perhaps a little

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slower in attaining to full development than some other varieties, the plants are very large and vigorous, giving an excellent yield. The leaflets are especially broad. Berries are large, roundish, oblate with a decided gray bloom; firm, juicy and of very good flavor. The variety is late in ripening, giving the first picking at the Station about July 21.

Hansell - *R. strigosus.*

This, at one time popular American red variety, was not introduced to the Station grounds till 1898, consequently there is scant data as to its fruiting qualities.

Hilborn—*R. occidentalis.*

This black-cap is quite popular in Ohio and Ontario, but with us it has not done well as yet, although the fruit is near medium size and quite sweet and juicy. First ripe, July 21; last, August 2.

Kansas—*R. occidentalis.*

This variety seems to be the closest rival to the Gregg upon our grounds, although in time of ripening it more nearly coincides with the Carman. The plants are of rapid, vigorous growth, berries similar to Gregg, fully as large, ripening a week earlier; juicy, excellent flavor, quite firm; yield good.

First picking, July 10; last, August 2; heaviest, July 19.

Loudon—*R. strigosus.*

This popular Wisconsin berry was originated at Janesville, being a cross between Turner and Cuthbert. It has not yet fruited on our grounds.

Marlboro - *R. strigosus.*

It is probable that this extremely popular red variety contains an admixture of European or Idæus "blood." By some authorities it is classified as a hybrid between the two species.

This variety has done rather better in neighboring grounds than on the station plat. It is a vigorous and productive early market variety and a thoroughly good all-purpose berry.

Mills—*R. occidentalis.*

This black-cap variety was set in the Station plat in 1898 and has not yet been fruited. The variety is thought to be a cross between Gregg and Tyler.

Miller—*R. strigosus.*

Set in Station plat in 1898; not yet fruited The variety is of the Brandywine type, but said to be considerably earlier.

Mohler—*R. occidentalis.*

This promising black-cap variety was set in the Station plat in 1898 and has not yet fruited. It is claimed to be a seedling of the Eureka, although considered by Prof. Green, of the Ohio Experiment Station, to be practically, if not actually, identical with that variety. It is certainly deserving of trial.

Ohio—*R. occidentalis.*

Introduced to Station grounds in 1898; not yet fruited. An established early variety in many sections. Much used for drying and for shipping fresh.

Palmer—*R. occidentalis.*

Introduced to Station grounds in 1898; not yet fruited. This variety originated in Ohio and has been reported favorably from many sections in the West, and seems to be well worthy of trial here.

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Pennock—*R. occidentalis.*

A black-cap of medium slender habit originated by Mr. Chas. E. Pennock, of Bellvue, Colo. The plant is a good, healthy grower, but has not yet fruited on our grounds.

Royal Church—*R. strigosus.*

While classified as an American red, it is quite possible that this variety is a hybrid and should be placed with the *Rubus neglectus* group.

It is a very large and vigorous variety with purple canes, although producing suckers quite freely. Berries are very large, dark crimson, excellent quality, medium firm, stand up well in quart boxes, but are inclined to crumble. It produced the heaviest yield of any variety on our ground in 1897.

First picking, July 21; heaviest, July 31; last, August 23.

Shaffer—*R. neglectus.*

This is an extremely vigorous variety of the purple cane group, of which it is the type. While propagating by root tips, the bushes and also the berries resemble the red raspberries more than they do the black, although the berries grow in clusters much like the black-caps. The berry is large, dark red or purple, moderately firm, nearly as good quality as the reds and richer. It is an excellent variety, but is used more for drying and for canning than for using in a fresh state.

This variety is difficult to lay down unless it is trained to the operation from the first year.

Strawberry-Raspberry, or Rose-Leafed Raspberry—*R. rosæfolius.*

This variety is merely a horticultural novelty in this country. The species is found growing wild in Japan and Eastern Asia. It is of no value except as an ornamental plant and has not endured on our grounds even with winter protection. The summer heat seemed too intense for it.

Thompson—*R. strigosus.*

One of the American reds. Introduced to Station grounds in 1898. Not yet fruited.

Turner—*R. strigosus.*

This is a very vigorous, almost thornless variety, which was very popular for many years. The principal objection is that the berries are rather soft. Berries large, dark red, medium to large, of good quality and yield. The yield is very steady for the first three weeks, the picking season with us being July 10 to August 11.

An excellent variety for home use.

Japanese Wineberry *R. phœnicolasius.*

Set in the Station plat in 1898; failed to fruit; died 1899. It is doing fairly well on some grounds in this section, but is of no commercial value. It is a vigorous, semi-trailing bush of handsome appearance, but so far as fruit is concerned will be of interest only to those who are interested in horticultural novelties. The species is found growing wild in Central and Northern Japan and has long been grown in this country as an ornamental. It was not boomed as a fruit plant till 1889-90.

BLACKBERRIES AND DEWBERRIES—*Rubus.*

But four types of blackberries enter into consideration in this section, viz: 1, the Long Cluster; 2, the Short Cluster; 3, the Loose Cluster, which are thought to be hybrids between the first two and the common Dewberries of the Eastern states; 4, Northern Dewberries. The tendency

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among the best growers of this section at the present time seems to be toward the 3rd class, which are more slender and flexible than the high bush varieties, but which, nevertheless, with proper pruning, hold their fruit well off the ground. All of this class that have been grown on our grounds seem to propagate quite freely by suckers and not by root-tips as is characteristic of Dewberries.

The common high bush berries are classified botanically as *Rubus villosus*, and Dewberries as *Rubus canadensis*. Most of the slender-caned loose-cluster varieties being evidently hybrids, are classified as *Rubus villosus* x *canadensis*?

Our old plantation was located on a hot and dry southwest slope, a very improper location, especially in connection with the fact that our supply of water usually fails about the time it is needed for the maturity of the fruit. As a result of these conditions the old plantation has been practically uprooted and a new one in a different location established. Many varieties new to the grounds, as well as all of the old ones, were set in this new plat, the rows of blackberries alternating with rows of black raspberries.

Agawam—*R. villosus.*

This variety is a representative of the short clustered group. It was introduced to the Station grounds in 1896, but has not yet borne fruit of consequence. We had an excellent stand of good thrifty plants. The variety is very popular in many sections; early in season and fruit of excellent quality.

Ancient Briton—*R. villosus.*

This variety is of the long cluster type. It was imported from England into Wisconsin somewhat over forty years ago, where it received its name and afterwards became very popular. It was introduced to our grounds in 1896, where it has obtained a good foothold, but has not yet fruited to any extent.

Dallas—*R. villosus* x *canadensis* (?).

This blackberry closely resembles the dewberries and is probably either the native Texan dewberry or a hybrid closely resembling the dewberries. The vines are much more upright than are those of the Lucretia or the Mayes Dewberry. The variety has made a good growth on our grounds, but has not yet fruited to any extent.

Eldorado—*R. villosus.*

This variety of the long cluster type originated in Ohio some time prior to 1882. The plants have made a good growth on our grounds, but have not yet fruited.

Erie—*R. villosus.*

This is a variety of the short cluster type originating in Ohio in 1876. The plants are thrifty, lighter green in color than our other varieties, producing a fair yield of fruit. Ripens mid-season, fruit large, short-oval, good quality.

Mayes—*R. canadensis.*

Although originating in Texas, this dewberry is of the Northern type. It has also been sent out under the name of Austin's Improved and reached

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our grounds under that name, but these plants failed to become established. The variety propagates by tips and by root cuttings. With us the plants are quite strong and vigorous and appear promising. They have not yet fruited, probably because of inclement seasons

Ohmer—*R. villosus.*

A variety of the long cluster type originated by Mr. Nick Ohmer of Ohio Our plants are vigorous and produced a good yield in 1897. It is mid-season to late; berries large and of good quality.

Rathburn—*R. villosus* x *canadensis.*

This belongs to the loose cluster group and is supposed to be a hybrid, though it is quite upright in habit and is propagated by suckers. The plants introduced to our grounds in 1898 have not done well and have not yet fruited. Mr. Pennock, a local nurseryman and fruitgrower considers this variety by far the best of any of the many he has tested on his grounds.

Snyder—*R. villosus.*

This old and best known variety is of the short cluster type. It makes a large vigorous growth with us but has not yet fruited.

Stone Hardy—*R. villosus.*

This is a variety of the short cluster type originating in Illinois. The most enchanting sight that the writer ever saw in the blackberry line was this variety growing at Madison, Wisconsin, so marvelously loaded with fruit that the large and luscious berries could be literally gathered by the handful. How it may succeed here with sufficient water for irrigation is yet uncertain, although the plants have done well.

Wilson Early—*R. villosus* x *canadensis.*

This variety of the loose cluster type and of hybrid origin was discovered in New Jersey in 1854. It is propagated both by root-tips and by suckers. It is a popular variety in New Jersey, demanding close pruning to prevent over-bearing. With us the plants have done well, giving us the best yield of any variety in 1897 and being about the only one to bear perfect fruit the past season.

Wilson Jr.—*R. villosus* x *canadensis.*

This variety, originated by Wm. Parry in 1875, is said for all practical purposes to be identical with its parent, Wilson Early. On our grounds they appear to be quite similar, but the "Jr." does not equal the "Early" in endurance of heat and drought.

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Bulletin 61. December, 1900.

The Agricultural Experiment Station

OF THE

Agricultural College of Colorado.

BROMUS INERMIS.

—BY—

F. L. WATROUS, H. H. GRIFFIN and J. E. PAYNE.

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The Agricultural Experiment Station

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Bromus Inermis.

F. L. WATROUS.

Referring to this grass, Press Bulletin No. 47, Kansas Agricultural Experiment Station, makes the following statements: "Awnless brome grass or Hungarian brome grass (*Bromus inermis*) is a native of the dry, sandy regions of Europe and Western Asia. It is a perennial, about the size and somewhat the general appearance of Meadow fescue or English blue grass. It spreads by creeping underground stems or rootstocks. It has been tested by many of the experiment stations, from Canada and North Carolina to Mississippi and California. All recommended it highly for dry, sterile, light or sandy soil."

So far as known *Bromus inermis* was first grown in Colorado at the Arkansas Valley Substation in the year 1892. Out of many different varieties, it alone gave sufficient promise to encourage a second trial. In 1894 the home Station at Fort Collins began investigations as to its value, since which time several sowings have been made in a variety of soils and under widely dissimilar conditions. The grass has been grown on heavy clay with scant irrigation, on the same soil with an ample supply of water, on light soil, above irrigation and on heavy soil, approaching "gumbo," with and without artificial watering. Under all these conditions the grass has succeeded to the extent that a thick, heavy sod has been formed, producing an abundance of forage of rather coarse quality, but readily eaten by horses, sheep and cattle. It has never produced hay in sufficient amount to be considered valuable for that purpose, but sown with alfalfa it promises to be of value for horses. In quality it is believed to be equal to orchard grass, or possibly as good as timothy. It is, of course, inferior to Colorado blue stem or buffalo grass, but where successful it will make up in quantity what it lacks in quality in comparison with these two grasses.

Brome grass produces a very heavy sod, which it is extremely difficult to plow when well set. The ground, to a depth of six or eight inches, will be completely filled with a mass of matted, fine roots, so that the sod will be turned over in solid slices, and remaining of so tough a texture that an excessive amount of

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preparatory cultivation is required in order to get in suitable condition to receive any other crop. The disk harrow is the only implement known which will finally subdue this sod. As to the effect on soil fertility, nothing definite is known, although a fair crop of flax was grown upon a plot of this sod ground the past season.

In Colorado *Bromus inermis* is specifically a pasture grass, and it may be truly said it is the only tame grass yet discovered which can, with any degree of success, take the place of the departing pasture grasses of the plains. The closest pasturing and severe tramping have had no effect in destroying the sod. After having been gnawed tight to the ground by sheep, it shows growth within a week after stock is removed, even in late fall when nights are frosty. In the spring brome grass affords pasture from two to three weeks earlier than any other grass known to this locality.

Many complaints are heard from various localities respecting the worthlessness of seed, all of which, thus far, has been imported from Europe. The Kansas Experiment Station reports that about ninety per cent. of this seed fails to grow. Experience at this Station last season seemed to verify this statement, though it is too early as yet to speak with precision in the matter, from the fact that brome grass comes up very much thicker the spring after sowing than would have been expected from its appearance in the fall. Whether this is due to some of the seed lying dormant, or to an extension of the root system at some time between fall and spring, has not been ascertained. The fact has been noted elsewhere, and thoroughly proven here, that it is best not to be discouraged over a seeming light stand the first season, but wait until the grass has a chance to show up the following spring before plowing it up or adopting any radical measures.

For spring sowing, brome grass should be sown early in this country if it is to be grown without irrigation. With irrigation it may be handled successfully by sowing at any time during the growing season. It requires a clean, well pulverized seed bed, such as wheat would thrive in, and should be covered from one to two inches in depth. Owing to the light, chaffy nature of the seed, we have been unable as yet to sow it evenly in an ordinary drill, though this would be the ideal way. It has been sown broadcast by hand and harrowed in. The condition of the soil is of more importance than the manner of sowing.

It would not be safe to recommend this grass for indiscriminate sowing. Farmers having portions of land above irrigation, or desiring permanent pasture on almost any kind of land that is not positively wet or boggy, would be justified in trying an acre or two. Sow fifteen to twenty pounds per acre. If successful, it produces a

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good quantity of seed the second year, after which the sowing may be extended with small expense.

The grass has done well and is very useful here. There seems no reason why it should not do well elsewhere.

TESTS ON THE GROUNDS OF THE AGRICULTURAL COLLEGE.

On May 17th, 1894, two plats of land comprising one and a fourth acres were sown at the rate of 16 pounds to the acre. This soil was a sandy, clay loam of such a composition as to have been, in its natural state, practically sterile. Owing to its location being such as to render it very difficult to irrigate, it had been allowed to remain untilled. The land was broken up and gotten in as good condition as possible by aid of disk harrow and roller and the seed covered in fairly good shape. It was irrigated once the first season and made a very poor stand, thickening a little the following spring, and finally at the end of four seasons, made a complete stand, since then producing an abundance of foliage or pasture, but was never allowed to head until the past season, when it produced fifteen bushels of seed.

Another acre was sown on May 25th, 1896, on heavy clay soil and was treated as to irrigation in exactly the same manner as contiguous plats of alfalfa. This plat made an excellent stand from the first and made and produced a crop of seed the second season.

April 9th, 1897, a pasture mixture, composed of barley, rye, oats, sandwicke and brome grass was sown on a small plat of ground for sheep pasture. When sheep were removed, bromus was the only crop to recover. Adjoining this plat, the following spring *Bromus inermis* was sown on about one acre of ground. It was endeavored to sow the seed with an ordinary grain drill. Various substances, as bran and dry soil, were mixed with the brome grass seed to give it sufficient weight to feed through the drill. It was found to be impracticable and the drill was discarded. After sowing, furrows were made about this plat so that one-fourth of the plat would not be watered when the rest was irrigated. The stand on this part was never quite so good as on the balance of the plat, though it was so good that a casual observer would not notice the difference. This lot has been pastured for three years with sheep. As there was always more sheep than the pasture would support, the grass was eaten close to the ground several times each year, i. e., when it was eaten so close that there seemed to be nothing left, the sheep were removed and when water was to be had it was turned on this pasture plat. In every instance the grass came up quickly and when a few inches high sheep were turned on again.

This same season another acre plat was sown for pasture. This soil was very heavy clay, probably as near an approach to regular "gumbo" as could be readily found in this vicinity. An excessive amount of work was necessary in order to get this land in shape for seeding. This however was accomplished and an excellent stand was the result. It was irrigated the first two seasons.

The first season after sowing, the grass having a good start in May, six ewes and their half grown lambs were turned on for pasture. It supported this number for about six weeks, when the grass being eaten down very close, the sheep were kept off and fed for a couple of weeks, in which time the grass recuperated and the sheep were turned on again. This plan was repeated twice more during the season, and in October the ground seemed as bare and nearly as hard as an ordinary road bed. The following spring, however, the brome grass made its appearance in March and with the same treatment each year is still thriving and furnishing as much pasture, to all appearance, as at first.

May first, 1899, two acres adjoining the above plat were sown. The ground had been covered during the winter with a very thick coat of coarse manure, so thick was it in fact that owing to the gumbo quality of the land and its persistent sticking to the plow, only about half the manure was covered up, the rest sticking out and producing a very unfavorable condition of seed bed. The seed was sown however, and covered as well as might be. This land became very dry and it was not thought possible that any of the seed could germinate. After all the other crops on the farm had been irrigated there came an opportunity to run the water on this piece, which was done. At the end of that season a few spears of brome grass were visible, but they were so few that it was thought the plat was

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an entire failure. Upon examination early in the following April however, so much improvement was noted that it was thought best to let the land alone, at least for one season, and note the result. By June first there was almost a complete stand of grass, so that sheep were pastured there the balance of the season till October, when the sheep being removed, the grass started up again during the warm days and frosty nights of October and November, showing a thicker stand than could be seen in the middle of summer.

Late in May of 1900, about 14 acres of raw, unproductive land was sown to brome grass at the rate of about 15 pounds to the acre. Considering the quality of the land, the lateness of the season, and the pressure of other work, this undertaking was very ill advised, and would seem to have promised nothing but failure from the first. However about half a stand was secured over a good portion of the land, and the coming spring will show what may be expected of this grass under the very worst conditions.

In the spring of 1898 an experiment was tried on a neighboring farm, of sowing bromus on a high knoll, above reach of irrigation. This soil was a good quality of sandy loam, and having never been irrigated is better calculated to receive and hold falling moisture than would soil which had been irrigated. A fairly good stand was secured here and it has gradually thickened since, producing good pasture, and has been particularly noticed each spring as producing green pasturage at least two weeks before alfalfa or any other grass.

April 9th, 1898, in a small field thickly sown with alfalfa, a strip 8 feet wide the length of the field was sown with *Bromus inermis* seed. Under ordinary treatment for alfalfa, this strip grew well, was cut three times each year and is still engaged in a struggle for supremecy with the king of the Colorado field. As both were thickly sown, neither crop is at its best, which would indicate that thinner sowing would be advisable where both are sown together.

Trials at the Arkansas Valley Substation.

H. H. GRIFFIN, Superintendent.

April 22, 1892, a plat 145 feet long, 67 feet wide, was sown to seed of *Bromus inermis*. An excellent stand was secured, and the records report it growing ten inches tall and producing seed. In 1894 this plat was harvested July 12th, and from the product 208 pounds of cleaned seed was secured. By this time the sod had become very close, and most of the growth made was around the edges of the plat. Wherever it was sub-irrigated the growth was from one to two feet high, but wherever flooded it became sod bound and made almost no growth.

This was about the manner of its growth the succeeding years, until the present Superintendent took charge, in March, 1898. Noting that it was making a very poor showing, a portion was given a dressing of gypsum, and a sharp implement in the nature of a sub-soil plow was run through the other portion to cut up the sod, thinking it might do better were it relieved of the sodded condition. Neither remedy proved to be of any benefit. The only growth of any importance was the narrow fringe around the edges, or on the ditch banks, where it secured sub-irrigation. It does not

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seem to withstand flooding. Becoming satisfied that no returns were to be secured by further allowing this to stand, it was plowed up in the fall of 1898. The sod was extremely compact, and much of the season of 1899 passed before it was rotted.

To a field of three acres that had been sown to rye in October, 1894, was added *Bromus* seed on April 9th, 1895, at the rate of twenty-six pounds per acre. The seed was harrowed in, and germination secured by irrigation. A fairly good stand was secured over the greater portion of the field. In 1896-97 it furnished some pasture during a portion of each year. In 1898, when first taking charge of the Station, it was noted that this grass started to grow very early in the spring. It made some growth until about the middle of May, when all development stopped. It remained in about this condition until fall rains occurred, when it made some further growth, but not enough to warrant giving it much consideration. It was also noted that where an application of barnyard manure was given, that the growth was increased considerably. It was further noted that while the grass would withstand considerable drouth without dying out, yet to secure any growth or vigor of plant a considerable amount of moisture was necessary, and this moisture should preferably be in the form of rain. Nine irrigations were given this field in 1897, between March 26th and October 1st. As before stated, where flooded it soon became sod bound. As the returns from this field did not warrant retaining it any longer, it was plowed up in May, 1899, and seeded to corn.

That this grass did not improve the fertility of the soil was apparent from comparisons of adjoining fields, both in 1899 with corn and in 1900 with oats. An adjoining field that had been in red clover, and plowed up at the same time of the *Bromus*, gave fully fifty per cent. greater yield in the two crops above mentioned.

Not being satisfied that the trials had been conclusive with this grass, and thinking that perhaps fall sowing would be of benefit in securing more favorable results, a field of one and one half acres was prepared, which was seeded with seventy pounds of *Bromus* seed, September 7, 1898. This land was irrigated by means of furrows two and one half feet apart through the land, in which the water was run, giving it sub-irrigation as much as possible. A splendid stand was secured, and the grass was up well before winter set in. It was given the best of attention in 1899, and the heavy rains of the summer and fall were conducive to its best development. The results of the year were promising, and it appeared as though this grass, under such conditions, would prove a valuable adjunct to the agriculture of this section. It was pastured but slightly in the fall of 1899, and by the 20th of April, 1900, furnished quite good pasture. One dairy cow was turned upon this lot and pastured for about six weeks. While there seemed to be a

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plenty of forage, the cow did poorly. She lost in milk and flesh, so much so that it was necessary to seek some further food to secure good results. Early in May this grass began to fail, and from that time to date of this writing (December 28th) has only lived, making no growth whatever.

The season has been very hot and dry, and under such conditions, which often prevail, the artificial application of water does not seem to be the requisite to produce growth and vigor of plant. Its behavior here tends to show that it is better adapted to a region of lower mean temperature and greater summer precipitation, and that the soil should contain much more clay—what would be termed a stronger soil. It becomes sod bound under irrigated conditions, and soon fails to produce growth of any value. The grass is coarse and very low in nutritive qualities. I see but one place where it may profitably be employed, and that is as a soil retainer on the banks of ditches that are liable to wash. The fact that it thrives where the water is applied in this way, and that it forms such a dense sod, would warrant its use in cases such as above mentioned.

Trials at the Plains Substation.

J. E. PAYNE, Superintendent.

1895. A plat was sown March 22nd on well prepared ground, which was broken in 1894 and thoroughly plowed in March, 1895. This seeding was blown out by spring winds. Later in 1895—June 6th—the same plat was sown to *Bromus inermis*. A good stand was obtained, but grasshoppers destroyed it all.

1896. Seed from an unknown source was used to sow a plat to *Bromus inermis*. The ground was well prepared, and had been cultivated in 1894 and 1895. None grew. The plat was seeded May 2nd.

1897. A plat was sown May 2nd, on well-prepared ground which had been in sorghum in 1894, 1895 and 1896. No stand was obtained—in fact no grass was seen to have grown from this planting. Seed: The same as that used in 1896. It was of unknown origin, but was bought from a reliable seed house.

1898. A two-acre plat was sown on land which had been well cultivated in sorghum and corn during the four years 1894, 1895, 1896 and 1897. Seed furnished by the Department of Agriculture was used. This seed was imported from Russia. A good stand came up, and the grass promised well until late in the

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summer, when the dry weather killed much of it which grew on the higher part of the plat. The grass remained green until late in the fall, and stood the winter well. It started in the spring of 1899, about the same time that the Colorado bluestem (*Agropyrum sp.*) started, but the dry weather in the summer destroyed nearly all except that which was in a low place, where extra water collected. This patch threw up a few seed-stalks twelve inches high. The spring of 1900, more especially April, was very wet. The remaining grass thickened and completely occupied the ground where it had secured a foothold (this was confined to about ten square rods which got the benefit of storm-water from the prairie). The seed-stalks grew twelve to twenty inches high, but they were thin on the ground. The main, leafy parts of the plants were too low to be cut by the mower.

1899. Seed sent out by the U. S. Department of Agriculture in 1898 was used to sow a plat on ground which had been cultivated in hoed crops since 1894, with the exception of one year, when it was in barley. Only a few plants appeared, and these died during the dry weather of the summer. This plat was sown April 20th.

1900. Fresh seed, grown in Manitoba, was furnished by the U. S. Department of Agriculture for seeding a plat this year. It was sown on well-prepared ground, which had been cultivated in hoed crops every year except one since and beginning with 1894. Only a few plants appeared, and these died during the summer. This plat was sown April 23d.

NOTE 1.—"Well-prepared ground" means that the land was plowed from five to eight inches deep and thoroughly harrowed until the seed-bed was practically free from clods. In 1898 and 1899 the land was plowed eight inches deep and packed with a sub-surface packer.

NOTE 2.—The choice land of the Farm was used every year except 1898, when a two-acre piece, which represented the wettest and the dryest land on the Farm, was chosen.

NOTE 3.—Seed. The seed used in 1895 and 1898 proved to be good by growing. The seed used in 1896 and 1897 may not have been good, as its origin was unknown. The seed used in 1899 was some which was left from the supply sent by the U. S. Department of Agriculture in 1898. The seed used in 1900 was fresh seed obtained from the Department of Agriculture, which was grown in Manitoba. Also some of the old supply sent by the Department of Agriculture in 1898 was sown. Both these gave about the same number of plants.

NOTE 4.—All seed was sown broadcast and harrowed in with a smoothing harrow.

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BROMUS INERMIS SEEN ELSEWHERE ON THE PLAINS.

Only one plat was seen growing. That was on the ranch of Robt. Lucore in the northern part of Lincoln county. I saw this plat in May. 1900. It then showed scattered bunches among the weeds. The grass appeared to be growing well, but was a very poor stand. It was a small plat. Mr. Lucore said that he thought *Bromus inermis* a good grass for his neighborhood, but he did not care to plant any more, even if the seed was furnished him free.

WEATHER AND COMPARATIVE CONDITIONS.

During the six years *Bromus inermis* has been tried here, the rainfall has been as heavy as usual. Native hay has been cut on the uplands every year, except 1900. No year of the six under consideration was as drouthy as were 1893 and 1894.

GENERAL COMMENTS.

1. In common with all so-called drouth-resistant plants, the testing of *Bromus inermis* has proved to be very unsatisfactory here. The failure to get a stand of plants is the greatest difficulty experienced. If rain does not fall at the right time after seeding, we are almost sure to fail to get a stand which will be fair to the plant under consideration. If a stand is obtained, continued drouth before the young plants are strong enough to resist it, may destroy all hope of successful termination of the trial.

2. While we feel that the grass (*Bromus inermis*) is a failure under the conditions existing here, we realize that it might succeed where conditions are not quite so unfavorable. A difference in the distribution of the rainfall might bring success where we have to record failure.

Our experience and observation compels us to recommend to those who think of trying *Bromus inermis* on unirrigated land in eastern Colorado, that they test it on a small scale for a few years, before plowing up buffalo grass to make room for it.

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Press Bulletin No. 3. May, 1900.

The Agricultural Experiment Station

THE STATE AGRICULTURAL COLLEGE,

FORT COLLINS, COLORADO.

THE BEET ARMY-WORM.

CLARENCE P. GILLETTE.

The caterpillar which did so much injury to sugar beets in the vicinity of Grand Junction last year will doubtless appear again this summer. While the insect has long been known to entomologists, last year was the first that it has ever been reported doing serious harm to any crop.

While the life habits of the insect have never been studied, it seems probable, from what the writer could learn of it last summer and fall, that it has two broods in the course of a year. The caterpillars that were so abundant during August last year entered the ground and then appeared again as moths in September. There were few enemies to destroy the caterpillars and the moths hatched in enormous numbers. These moths, like house-flies and mosquitoes, seek every available place of protection from winter's storm and cold that they may live (hibernate) until spring. When vegetation starts the moths laden with eggs, go in search of beets, or other plants furnishing suitable food, to deposit their eggs and thus provide for an early brood of worms. If ten per cent. of the fall brood of moths survived the winter, there is serious danger that beets will fare worse this summer than they did last, unless growers are early on their guard to make thorough and timely application of effectual remedies. Just here let me warn all against experimenting with new or patent remedies which some friend or vender may think entirely satisfactory. Use such remedies very cautiously and sparingly at first, or do not use them at all.

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From what could be gathered last summer, it seems that there was a first brood of caterpillars at about the time for thinning the beets, which, in some cases, destroyed most of the plants after thinning.

REMEDIES.

Experiments tried last summer proved that the common poisons, Paris green, London purple, and white arsenic, will destroy the caterpillars if well distributed upon the beets. These poisons may be applied dry or in water. If the caterpillars appear upon the beets while the latter are small, I believe the best method of application is to mix one part by weight of Paris green or London purple with twenty parts of common flour, and then dust the mixture over the plants before sunrise in the morning. In this strength a light dusting will be sufficient. The early application is recommended, because then the leaves have a slight amount of moisture upon them, which helps to hold the flour and poison. Just after the leaves are moistened by a shower is also a good time to make the application.

To apply the poison, make a small cheesecloth sack about five inches in diameter and ten inches deep. Fill it with the mixture of poison and flour and walk along a row of plants shaking the sack over them. This can be done quite rapidly when one has learned how and is economical of poison, and does not require wheelbarrow or wagon to carry pump and tank.

When the plants become large, as in case of treatment for the second brood, it will probably be better to use a barrel or tank and spray pump.

If a spray is used, apply either Paris green or London purple in the proportion of a pound to 100 gallons of water and add two pounds of fresh lime for each pound of poison. The lime should be slaked and strained through a sack to take out lumps. Then use a nozzle that throws a fine spray, and do not continue the application in any place long enough so that the drops sprayed upon the leaves will run together and flow off, carrying the poison with them.

If white arsenic is used, prepare according to the following directions:

Put two pounds of white arsenic and eight pounds of sal soda together in a dish and boil for twenty minutes in two gallons of

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water, and keep as a concentrated solution. *It is extremely poisonous and should be placed at once where there is no possibility that children or domestic animals can get it. Also, label it "poison" in large letters.*

Then, in each 40 gallons of water, first slake four pounds of lime and then add slowly one quart of the concentrated solution while the whole is being stirred. The mixture is then ready for application, as in case of Paris green. The lime should be strained through a cloth to take out the lumps.

I am advising the use of these poisons somewhat stronger than is common, but the experience of last year makes it seem advisable to do so.

Growers should keep the closest watch of their beets this year, in order not to let the caterpillars get the start of them. I hope to be notified of any appearance of these worms or other injurious insects promptly, and shall be glad to do all in my power to aid those who are anxious to save their crops from the attacks of such pests.

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THE COLORADO EXPERIMENT STATION (a Department of the State Agricultural College), issues several classes of publications on subjects relating to Colorado agriculture. Bulletins, of which over fifty have been printed, are mailed as issued to those who desire them, as far as the edition permits, and without cost. A list of those already issued can be supplied. The Press Bulletins are distributed according to the subject matter. The Annual Reports are larger publications, principally devoted to administrative and technical matter. These are printed in small editions and sent only on special request, or to those to whom they are specially useful.

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Director of the Experiment Station,
Fort Collins, Colorado.

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Press Bulletin No. 4. June, 1900.

The Agricultural Experiment Station

THE STATE AGRICULTURAL COLLEGE,

FORT COLLINS, COLORADO.

THE CANTALOUPE BLIGHT.

By H. H. GRIFFIN,
Superintendent Arkansas Valley Substation.

Rocky Ford, Colorado, has long been famous for its cantaloupes. Until of late the industry has moved along at a rapid pace, little disturbed by insects or plant diseases. The blight, or rust, was first noticed on a few patches in 1896. There was an increase of the disease in 1897, more especially on the same fields, but its spread was not sufficient to cause much alarm. There was a vast extension of the disease in 1899 and the severity was much greater. The disease seemed to spread from a few well defined centres and grew less with distance from these centres. Many points in the Arkansas Valley report no injury. All evidence shows that the disease is not caused by any particular soil conditions, mode of irrigation, or peculiarity of climate.

The station began to investigate the question in 1898. Prof. Crandall, in 1899, pronounced the trouble due to a fungus, a new species named by Ellis and Everhart "*Macrosporium cucumerium.*"

Seed taken from diseased melons was planted in 1899 to see if the disease was communicated by the seed. Three rows, each 250 feet long, were planted May 12th. The middle row was sprayed with Bordeaux mixture to test its efficacy as a preventative, or, should the disease appear, for its control. Sprayings were given to the middle row June 22nd, June 30th, July 22nd, July 31st and August 11th. At the

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time of the first spraying there was no appearance of the blight, but at the time of the second spraying it was noted that "something on the leaves that looked like blight" had appeared. Previous to the 19th of June the weather had been very dry, so that if any infection had been present it is not probable that its spread would have been rapid enough to become apparent. After this moisture was plentiful; seven inches of rain fell in July; 5.14 inches in the week commencing July 14th. These rains submerged the vines and could not fail to wash off the spray. At the third spraying the blight was strongly in evidence. In August 2.22 inches of rain fell and dews were prevalent. A decided benefit was derived from the sprayings made after the 22nd of July. The sprayed vines held up comparatively well, and the fruit was of good quality. On the unsprayed vines the fruit ripened prematurely; they were insipid in taste, and it could be detected from which vines they were picked. The sprayed vines remained green and in a growing condition for two or three weeks after the others had succumbed. The plants grown from diseased seed did not seem to be more susceptible than those grown from seed from healthy vines.

Other experiments were inaugurated in the latter part of July on a more extensive scale. Both the Bordeaux mixture and an ammoniacal copper carbonate solution were used on different vines at each place. The first spraying with the Bordeaux mixture was given July 27th and the last August 18th. The carbonate was first used August 4th and the last spraying was made August 18th.

The test was made on seven rows, each 275 feet long, the vines that were sprayed remaining in good condition fully ten days after the others were gone. The melons ripened slower, in better condition, and were of uniformly good quality.

The results from the carbonate were not so pronounced as from the Bordeaux mixture. The results from the above work were so promising that it was tested on a still more extensive scale. About ⅛ of an acre of melons belonging to Senator Swink were sprayed. About one acre was sprayed

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for Mr. John Deweese, and one and three-fourths acres for Mr. C. S. Fenlason. Only one application was made at these places. These sprayings were done late in the season, when the blight was spreading rapidly. These melons were surrounded by others which were blighting badly.

The work confirmed the result of the other trials. Mr. Fenlason sold 300 crates of good melons from his sprayed field.

The virtue of the spraying lies largely in the ability of of the melons to ripen properly, *i. e.*, to perfect the quality; the benefit is not alone to the vine.

It took 22 pounds of bluestone to spray the vines at Mr. Fenlason's, which were very large. The estimated cost was $6.75 per acre. Had the work been done earlier the cost would have been much less.

APPEARANCE OF THE DISEASE.

The cantaloupe blight is caused by a true parasitic fungus. To the casual observer the first appearance is a large number of small brown spots upon the leaves in the center of the hill. If the younger leaves are examined, it will be seen when the fungus is at work some time before the brown spots make their appearance. It can be seen when the leaf tissue has been eaten away, and when the injured tissue dies the brown appearance occurs. These brown spots grow larger as the fungus kills the tissue, until they become so numerous as to envelop the whole leaf; it appears as though struck by frost. It is surprising how quickly the spray will prevent the enlargement of these spots upon the leaf. At the time spraying is required the melon vine is making quite rapid growth, which necessitates spraying at intervals in order to cover the new growth.

HOW THE ACTION IS PERFORMED.

It can be readily seen that if some material is put upon the leaves that will kill the fungus, without injuring the host plant, that the desired action is performed.

No fear need be felt that bees will be poisoned. A

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number of hives stood near one of the fields treated, but no dead bees were found nor could it be seen that any injury resulted to them.

From the work of this season, we can advise that two or three sprayings be given should the weather conditions prove favorable for the spread of the disease. If a dry season occurs perhaps the disease will not develop to any injurious extent.

From our present knowledge we should say that the first spraying should be done about the middle of July, followed every ten days until two or more are given, depending upon the weather. It would be well to follow the first rains of July with a spray.

Directions for making Bordeaux Mixture for use upon cantaloupes:

Dissolve 6 lbs. of bluestone.
Slack 4 lbs. of fresh lime.

When the lime has become cool strain off the milk, adding it to the bluestone. Add water until there are 40 gallons.

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Press Bulletin No. 5. July, 1900.

The Agricultural Experiment Station

THE STATE AGRICULTURAL COLLEGE,

FORT COLLINS, COLORADO.

THE RUSSIAN THISTLE AS FORAGE.

By J. E. PAYNE,
Superintendent Plains Substation.

In many localities, the Russian thistle threatens to take possession of the land, in spite of all efforts of public-spirited people to keep it in check.

In neighborhoods where it has taken possession of the land, it seems best to ask—Can it be used for the benefit of the people whose land it has invaded?

The value of the Russian thistle has never been tested by a feeding experiment at any Experiment Station so far as we know, but the Minnesota Station has analysed the plants in various stages of growth. The following, copied from the Experiment Station Record, page 553, Vol. 6, gives the substance of Bulletin No. 34 of the Minnesota Experiment Station:

"When young the thistle is claimed to have a high food value, especially for sheep, which, some claim, are attracted to it merely on account of the salt which it contains. The chemical analysis shows a large percentage of ash material, amounting to nearly one-fifth of the dry weight of the plant. This is a serious objection to its use as a fodder plant, on account of the alkaline nature of the mineral matter present. One favorable point, as shown by analysis, is the large amount of nitrogenous matter present, being as much as there is in clover or rape. Before the development of the thorns, there is not much fiber present; at this time the plant is more valuable as a food than when mature. When the plant is ripe, the fiber and mineral matter make up half its composition, and although rich in nitrogenous matter, the former elements greatly reduce its feeding value.

"The ash analysis shows that the weed has strong foraging powers, there being large amounts of potash and lime taken up by the plant. The draft

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which the plant makes upon the sodium in the soil is a benefit to alkali lands. The amount of sodium present varies greatly with conditions, showing that the plant is able to adapt itself to the alkaline conditions of the soil. From the time the thorns are out until the plant matures it takes up a large amount of sodium from the soil, and only small amounts of other materials, hence it makes its heaviest draft upon the soil while in an immature state, after which it takes but little essential plant food."

The following testimony concerning the use of Russian thistles as food for stock has been gathered from men who have had more or less experience in feeding it:

"Cattle eat Russian thistles, but they are poor feed."

CHAS. HACKENBERGER,
Burlington, Colo.

"Cattle will eat Russian thistles in large quantities. They physic cattle."

THOMAS SEAMAN,
Wallet, Colo.

"Cattle eat Russian thistles. They seem to do well on them."

ELMER BROWN,
Wallet, Colo.

"I am feeding my bulls, which I keep up, Russian thistle hay. Consider it good feed when cut before the thorns harden."

SAMUEL P. SHAW,
Lamborn, Kansas.

"During the winter of 1899–1900, I fed a part of my cattle millet, and the remainder, about 40 head, Russian thistle hay. Those fed Russian thistles wintered fully as well as those fed millet. Fed none except during storms. Fed Russian thistles to those that were the best rustlers."

LEO THOMAN,
Burlington, Colo.

"In June, 1895, my cows fed on young Russian thistles. I never made better butter nor more of it than it did that month."

A. C. WILLIS,
Lamborn, Kansas.

"My sheep eat Russian thistles, both green and dry. I think a patch of Russian thistles worth as much, for sheep feed, as the same area in grass."

WM LANG,
Cheyenne Wells, Colorado.

"When I first began farming here, when wheat failed I had no feed for stock. Now, when wheat fails, Russian thistles take possession of the ground. I cut these and winter my cattle on them."

JOSEPH RUBY,
Thurman, Colorado.

The investigation has not been carried far enough to warrant us in recommending the Russian thistle as a hay plant when there is plenty of other forage. But the above testimony convinces us that those whose land is occupied by the thistles should cut some and try them as a feed for stock.

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Press Bulletin No. 6. December, 1900.

The Agricultural Experiment Station

THE STATE AGRICULTURAL COLLEGE,

FORT COLLINS, COLORADO.

A SO-CALLED BLIGHT CURE.

By CARL H. POTTER, Assistant Horticulturist.

The "Woodbury Blight Cure," as its name implies, is a proprietary article that has recently been placed on the market. This "cure" is guaranteed to be a certain remedy for the blight of apple and pear trees if used as directed, and a destroyer of insect pests as well. Two mixtures are sold by the company controlling the cure, a body wash and a summer spray. The claims for the remedies and the directions for their use as set forth by the company, are as follows: *

"The body wash should be used at least once during the season, preferably early in the spring on account of sun scald, but of immense benefit any time in the year.

"The summer spray should be used at least three times during the season for the cure of the blight and the destruction of insect pests. It should be used after, or during, every severe electrical storm for an insurance against the twig blight.

"Spray the first time when the trees begin to leaf, again from the middle to the last of July. Follow these directions carefully, and we will guarantee a cure for blight and the practical destruction of the codling moth and other injurious insects. The spray is beneficial and will promote a strong, healthy growth in all plant life, more especially on roses and vines. It will destroy slugs and green flies in the green-house."

On account of the fact that a large sale of such cure had been made, and that many inquiries had come to the Station, it seemed proper for a trial to be made.

June 29, 1898, a number of bearing apple trees in the Station orchards were selected and prepared for trial. Four distinct series or lots of trees were treated, while the others, as similar as it was possible to select them, were wholly untreated. These entered the test merely as checks with which to compare the trees that were treated. All of the trees to which the remedies were applied were recorded as class "A," while the untreated, or check trees, were class "C."

The different series of trees comprised summer, fall, and winter apples, and varied from very slight affection of the twigs to quite severe cases of blight, in which many of

* From printed directions provided by the company.

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the smaller limbs were entirely diseased, the blight even forming large and more or less concentric patches on the larger limbs about the bases of the smaller ones. The trunks were not very badly affected by blight, yet there was plenty present for a test. Those trunks that were rough, whether in class "A" or class "C," were thoroughly scraped before treatment.

On the afternoon of June 29th the trunks and the lower portions of the limbs, to a height of about four feet from the ground, of the trees of class "A" were treated to an application of Woodbury's "wash," the material being applied with a stiff paint brush. About one quart of the mixture was used for each tree.

The following afternoon, June 30th, the same trees were thoroughly sprayed with the "spray mixture." The mixture was used double strength, as the directions recommended where an early spraying had not been given. The material was thoroughly stirred and then diluted to the strength of $\frac{4}{5}$ of a quart of "wash" to $4\frac{4}{5}$ gallons of water. Five gallons of this diluted mixture were used on each tree, the services of one man being constantly required to agitate the liquid in the box of the spraying pump. Blighted parts received especial attention.

August 13th all of the trees in class "A" were sprayed as before, except that the spray or "cure" was used as diluted in the proportion of one part of spray to 49 parts of water. November 15th the trunks of all the trees in class "A" were washed as before.

April 18th, 1899, the trunks were again painted with the wash, a very thorough job being done. The trees were entirely dormant.

April 21st. Trees sprayed as per directions. Still dormant.

July 19th. Trees again sprayed as per directions.

This completed the application of the remedies to the trees. They had been used nearly two seasons, and were carefully and conscientiously applied. Frequent and careful observations of the trees were made, not only during the two seasons named, but extending through the season just closed. *We have not been able to detect, in any way, the slightest benefit to the trees as a result of the use of these materials.*

Concerning the value of the spray as an insecticide, Prof. Gillette makes the following statement:

"I have tested the 'Woodbury Blight Cure,' summer spray, upon both leaf-eating and sap-sucking insects, and in no case did it seem to have any injurious effect upon the insects treated. Leaves thoroughly wet with the solution were eaten by insects which afterward matured in perfect condition."

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No. 12. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

July 4 to July 10, 1900.

The rapid decrease in the volume of the river has continued during the week, the drop having been 575 feet as against 340 feet normally. The average of the week is but 871 feet, while the normal is 1,157 feet. Normally the average of the coming week is 250 feet lower than the present week, and the week following 200 feet still lower.

The following table shows how 1900 compares with the normal and with 1884, which was an exceptionally high year:

WEEK.	1900.	NORMAL.	1884.
April 4-10	224	75	72
" 11-17	359	145	112
" 18-24	1005	264	197
" 25-1	1915	459	593
May 2-8	2422	583	521
" 9-15	2749	896	1703
" 16-22	2274	1323	3841
" 23-29	3394	1691	4089
" 30-5	3908	2004	3970
June 6-12	3826	2142	4963
" 13-19	2845	2055	4936
" 20-26	2364	1804	4848
" 27-3	1446	1492	4710
July 4-10	871	1157	3380
" 11 17	....	902	2111
" 18-24	....	690	1367
" 15-31	....	580	1159

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
July 4	1042	2235	1305	....	....
" 5	958	2104	1228	....	....
" 6	871	2245	1128	....	....
" 7	853	2207	1171	....	....
" 8	827	1673	1136	....	....
" 9	795	1588	1083	....	....
" 10	752	1481	1045	....	....
Average.	871	1933	1157		

The corresponding week in previous years has averaged, in second feet:

1881	1329	1889	695	1895	1220
1884	3361	1890	814	1896	461
1885	2442	1891	829	1897	891
1886	931	1892	991	1898	584
1887	837	1893	850	1899	1933
1888	522	1894	1078	1900	871

L. G. CARPENTER,
Agricultural Ex. Station, Fort Collins, Colo., July 10, 1900.

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No. 13. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

July 11 to July 17, 1900.

The river has continued to decrease during the week, and shows practically the normal difference as compared with the previous week. For the whole week the average has been only about two thirds of the normal, and less than one-half of the corresponding week of last year. The rainfall at college amounted to .17 of an inch; at Chambers lake, where a thermograph is kept by the courtesy of Mr. McNabb, there seems to have been nothing more than short showers up to Sunday. Water Commissioner Hawley reports on Monday a total of 533 feet being furnished river appropriators, and an additional supply of 242 feet from exchanges.

The following table shows how 1900 compares with the normal and with 1884, which was an exceptionally high year:

WEEK.	1900.	NORMAL.	1884.
April 4-10	224	75	72
" 11-17	359	145	112
" 18-24	1005	264	197
" 25-1	1915	459	593
May 2-8	2422	583	521
" 9-15	2749	896	1703
" 16-22	2274	1323	3841
" 23-29	3394	1691	4089
" 30-5	3908	2004	3970
June 6-12	3826	2142	4963
" 13-19	2845	2055	4936
" 20-26	2364	1804	4848
" 27-3	1446	1492	4710
July 4-10	871	1157	3380
" 11 17	630	902	2111
" 18-24	....	640	1367
" 15-31	....	530	1159

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
July 11	705	1403	968	....	....
" 12	666	1739	982	....	....
" 13	641	1650	970	....	....
" 14	625	1482	896	....	....
" 15	597	1462	871	....	....
" 16	599	1349	827	....	....
" 17	576	1164	807	....	....
Average.	630	1464	902		

The corresponding week in previous years has averaged, in second feet:

1881	744	1889	518	1895	1388
1884	2112	1890	582	1896	433
1885	1827	1891	529	1897	877
1886	658	1892	736	1898	630
1887	860	1893	602	1899	1464
1888	416	1894	940	1900	630

L. G. CARPENTER,
Agricultural Ex. Station, Fort Collins, Colo., July 17, 1900.

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No. 14. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

July 18 to July 24, 1900.

The rainfall of the week, which amounted to .69 inches at the college, has kept up the river so that the rate of decrease has been less than in the few weeks preceding. Nevertheless, the average for the week is but little over one-half of the corresponding week of 1899.

Water Commissioner Hawley reports the water being distributed as follows: Pleasant Valley & Lake canal 65 feet, of which 25 feet is by reservoir exchange; Larimer County 205 feet, 88 feet of which is from reservoirs; Larimer and Weld 20 feet; No. 2 Greeley 110 feet; Dry Creek 20 feet; Little Cache la Poudre 12; New Mercer 4; Arthur 25; No. 3 Greeley, Boyd, etc., 60; small ditches 15 feet, or a total of 536 feet, of which 113 feet are from reservoirs. The reservoir of No. 2 ditch is now being called on for a small supply.

The following table shows how 1900 compares with the normal and with 1884, which was an exceptionally high year:

WEEK.	1900.	NORMAL.	1884.
April 4-10	224	75	72
" 11-17	389	145	112
" 18-24	1005	264	197
" 25-1	1915	459	593
May 2-8	2422	583	521
" 9 15	2749	896	1703
" 16-22	2274	1323	3841
" 23-29	3394	1691	4039
" 30-5	3908	2004	3970
June 6-12	3826	2142	4983
" 13-19	2845	2055	4936
" 20-26	2364	1804	4848
" 27-3	1446	1492	4710
July 4-10	871	1157	3380
" 11 17	630	902	2111
" 18-24	533	690	1367
" 15-31	....	530	1159

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
July 18	531	1075	788	....	....
" 19	525	994	749	....	....
" 20	525	995	704	....	....
" 21	451	993	711	....	....
" 22	460	991	661	....	....
" 23	475	1006	613	....	....
" 24	736	961	607	....	....
Average.	533	1002	690		

The corresponding week in previous years has averaged, in second feet:

1881	674	1889	362	1895	974
1884	1367	1890	682	1896	435
1885	1506	1891	389	1897	671
1886	642	1892	561	1898	349
1887	723	1893	419	1899	1002
1888	318	1894	697	1900	533

Normal next week, 530.

L. G. CARPENTER,

Agricultural Ex. Station, Fort Collins, Colo., July 24, 1900.

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Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

July 25 to July 31, 1900.

Storms in the mountains during the early part of the week, not only maintained the river, but caused the average to be higher than the preceding week, and higher than the normal for the same week. It is about one-half the corresponding week of last year.

Water Commissioner Hawley reports on the 31, the Pleasant Valley as drawing 40 ft. from river on account of priority and 15 ft. on exchange from reservoirs, Larimer County, 119 ft. from mountain watersheds and reservoir exchange, Larimer & Weld a total of 45 ft. of which 20 feet is from reservoirs, Greeley No. 2, 20 feet, other ditches 130 ft. The Larimer & Weld reservoir is now being called on for about 125 ft. The Cache la Poudre No. 2 reservoir completed the first run during the week.

The following table shows how 1900 compares with the normal and with 1884, which was an exceptionally high year:

WEEK.	1900.	NORMAL.	1884.
April 4-10	224	75	72
" 11-17	239	145	112
" 18-24	1005	264	197
" 25-1	1915	459	593
May 2-8	2422	583	521
" 9 15	2749	896	1703
" 16-22	2274	1323	3841
" 23-29	3394	1691	4089
" 30-5	3908	2004	3970
June 6-12	3826	2142	4983
" 13-19	2845	2055	4986
" 20-26	2364	1804	4848
" 27-3	1446	1492	4710
July 4-10	871	1157	3380
" 11 17	680	902	2111
" 18-24	533	690	1367
" 25-31	616	530	1159
Aug 1-7	...	462	996
" 8-14	....	375	829
" 15-21	....	241	859
" 22-28	....	277	625

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
July 25	767	736	562	....	....
" 26	719	933	560	....	....
" 27	641	1055	550	....	....
" 28	592	1030	525	....	....
" 29	558	1020	504	....	....
" 30	527	978	510	....	....
" 31	506	808	501	....	....
Average.	616	937	530		

The corresponding week in previous years has averaged, in second feet:

1881	456	1889	336	1896	772
1884	985	1890	376	1896	449
1885	1159	1891	295	1897	456
1886	463	1892	401	1898	247
1887	442	1893	392	1899	937
1888	331	1894	515	1900	616

The rainfall for July has been below the normal, being 1.14 while the normal is 1.91 in. Total this year 16.71 while the normal is 10.42. Most of the excess came in April.

L. G. CARPENTER,
Agricultural Ex. Station, Fort Collins, Colo., July 24, 1900.

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Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

August 1 to August 7, 1900.

The river gradually fell until the 5th, since then it has been a little higher. The week averaged 389 cubic feet, which is about 20 per cent. less than the normal. The week in the valley has continued dry, the rainfall at the college for the week only amounting to .03 inches.

Through an error in changing inches to feet, the flow of the river one week ago was given from 20 to 90 feet too high, and the average for the week 65 feet too high. The formula at this depth may be a few feet too high, for a measurement made on the 2nd.

Water Commissioner Hawley on the 6th reports Timnath reservoir still running water, Terry Lake reservoir as having two runs left in storage, Chamber's Lake intact, and Long Pond with only nine feet left in storage. The North Poudre reservoirs will begin running water for the Larimer and Weld as exchange water on the 8th.

The following table shows how 1900 compares with the normal and with 1884, which was an exceptionally high year:

WEEK.	1900.	NORMAL.	1884.
April 4-10	224	75	72
" 11-17	359	145	112
" 18-24	1005	264	197
" 25-1	1915	459	593
May 2-8	2422	583	521
" 9 15	2749	896	1703
" 16-22	2274	1323	3841
" 23-29	3394	1691	4089
" 30-5	3908	2004	3970
June 6-12	3826	2142	4983
" 13-19	2845	2055	4936
" 20-26	2384	1804	4848
" 27-3	1446	1492	4710
July 4-10	871	1157	3360
" 11 17	630	902	2111
" 18-24	533	640	1367
" 25-31	551	530	1159
Aug 1 7	389	462	996
" 8-14		375	829
" 15-21		241	859
" 22-28		277	625

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
Aug. 1	369	763	497	....	....
" 2	355	762	493	....	....
" 3	341	787	487	....	....
" 4	374	982	475	....	....
" 5	430	979	486	....	....
" 6	435	846	433	....	....
" 7	392	810	415	....	....
Average.	389	847	462		

The corresponding week in previous years has averaged, in second feet:

1881	390	1889	317	1896	701
1884	996	1890	283	1898	273
1885	1007	1891	287	1897	560
1886	295	1892	297	1898	201
1887	376	1893	291	1899	847
1888	335	1894	459	1900	389

The normal for next week is 375.

L. G. CARPENTER,

Agricultural Ex. Station, Fort Collins, Colo., Aug. 7, 1900.

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No. 17. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

August 8 to August 14, 1900.

The flow of the river has continued to gradually decrease during the week, averaging 275 cu. ft. per second which is 100 cu. ft. less than the normal for the same week. The weather has continued warm and dry, only a trace of precipitation at the college during the week. Neither were there any storms in the mountains sufficient to affect the flow of the river.

Water Commissioner Hawley on the 13th reports the water being distributed as follows: Pleasant Valley and Lake Canal 40 ft., Larimer County 73 ft., Dry Creek 12 ft., Larimer & Weld 20 ft., Coy 8 ft., small ditches 20 ft., Mill and below 50 ft.

The following table shows how 1900 compares with the normal and with 1884, which was an exceptionally high year:

WEEK.	1900.	NORMAL.	1884.
April 4-10	224	75	72
" 11-17	389	145	112
" 18-24	1005	264	197
" 25-1	1915	459	593
May 2-8	2422	583	521
" 9 15	2749	896	1703
" 16-22	2274	1323	3841
" 23-29	3394	1691	4089
" 30-5	3908	2004	3970
June 6-12	3826	2142	4983
" 13-19	2845	2055	4936
" 20-26	2364	1804	4848
" 27-3	1446	1492	4710
July 4-10	871	1157	3360
" 11 17	690	902	2111
" 18-24	533	690	1367
" 25-31	551	580	1159
Aug 1 7	389	462	996
" 8-14	275	375	829
" 15-21	....	341	859
" 22-28	....	277	625

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
Aug. 8	315	762	388	....	....
" 9	299	793	401	....	....
" 10	292	730	404	....	....
" 11	276	665	380	....	....
" 12	230	626	364	....	....
" 13	247	592	344	....	....
" 14	235	547	345	....	....
	1924	4715	2626		
Average.	275	674	375		

The corresponding week in previous years has averaged, in second feet:

1881	—	1889	193	1896	557
1884	829	1890	316	1896	190
1885	723	1891	192	1897	467
1886	243	1892	253	1898	165
1887	802	1893	291	1899	674
1888	181	1894	425	1900	275

The normal for next week is 341.

L. G. CARPENTER,
Agricultural Ex. Station, Fort Collins, Colo., Aug. 7, 1900.

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No. 18. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

August 15 to August 21, 1900.

The flow of the river during the past week has remained steady, very little change having occurred. The week has averaged 215 cubic feet, while the average for the week has been 341 cubic feet, or 126 cubic feet less than the normal.

The week has continued warm and dry, only .09 inches of precipitation has fallen at the college during the week. No storms have occurred in the mountains to affect the stream during the week. Since May 1st the precipitation has been 3.83 inches, which is the dryest since 1880.

Water Commissioner Hawley on the 20th reports the water being distributed as follows: Pleasant Valley and Lake, 40 feet; Larimer County, 59 feet, 35 feet of which comes from the Laramie river; Dry Creek, 12 feet; Larimer and Weld, 20 feet; Coy, 5 feet; Mill and below, 32 feet; small ditches and leakage through headgates, 20 feet.

The following table shows how 1900 compares with the normal and with 1884, which was an exceptionally high year:

WEEK.	1900.	NORMAL.	1884.
April 4-10	224	75	72
" 11-17	389	145	112
" 18-24	1005	264	197
" 25-1	1915	459	593
May 2-8	2422	583	521
" 9-15	2749	896	1703
" 16-22	2274	1323	3841
" 23-29	3394	1691	4089
" 30-5	3908	2004	3970
June 6-12	3826	2142	4983
" 13-19	2845	2055	4936
" 20-26	2364	1804	4848
" 27-3	1446	1492	4710
July 4-10	871	1157	3360
" 11 17	630	902	2111
" 18-24	533	690	1367
" 25-31	551	580	1159
Aug 1-7	389	462	996
" 8-14	275	375	829
" 15-21	215	341	859
" 22-28	....	277	625

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
Aug. 15	214	502	334	....	....
" 16	218	681	346	....	....
" 17	218	500	334	....	....
" 18	218	465	397	....	....
" 19	214	429	340	....	....
" 20	212	393	324	....	....
" 21	210	356	312	....	....
Average.	215	475	341		

The corresponding week in previous years has averaged, in second feet:

1881	—	1889	165	1896	427
1884	859	1890	367	1896	272
1885	496	1891	229	1897	312
1886	354	1892	176	1898	130
1887	303	1893	239	1899	475
1888	194	1894	313	1900	215

The normal for next week is 277.

L. G. CARPENTER,
Agricultural Ex. Station, Fort Collins, Colo., Aug. 21, 1900.

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No. 19. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

August 22 to August 28, 1900.

The river has remained constant during the week, and nearly the same as for the preceding week, and shows an average of 203 sec. ft. compared with the normal of 277 feet and of 331 feet for last year. Of this amount 50 feet were reported coming from Chambers lake and 25 from Laramie river on the 27th.

The following is the record for the week in second feet:

Date.	1900.	1899.	Normal	Highest	Lowest
Aug. 22 ...	248	341	303	....	....
" 23 ...	195	343	303	....	....
" 24 ...	200	335	289	....	....
" 25 ...	198	320	285	....	....
" 26 ...	215	322	265	....	....
" 27 ...	212	318	241	....	....
" 28 ...	201	335	255	....	....
Average.	203	331	277		

The corresponding week in previous years has averaged, in second feet:

1881.....	—	1889.....	125	1895.....	366
1884.....	625	1890.....	250	1896.....	342
1885.....	512	1891.....	246	1897.....	232
1886.....	339	1892.....	144	1898...	129
1887.....	256	1893.....	198	1899.....	331
1888	129	1894.....	230	1900.....	203

Rainfall for week .04 in. Only 0.16 in. so far this month while the average of the month is 1.30 in.

The normal for next week is 242.

L. G. Carpenter,

Agricultural Ex. Station, Fort Collins, Colo., Aug. 21, 1900.

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No. 20. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

August 29 to Sept. 4, 1900.

The amount of water in the river has continued to decrease, falling from 204 feet at the beginning of the week to 143 at the close.

The average, 185 feet, is not much in excess of the corresponding week of the previous low years. The small precipitation since April has caused a large demand for water, which has had to be supplied by artificial irrigation and has lessened the available supply. The precipitation in August was but .16 inch while the normal is 1.30 inch.

The following is the record for the week in second feet:

Date.	1900.	1899.	Normal	Highest	Lowest
Aug. 29 ...	204	340	255	....	....
" 30 ...	199	366	243	....	....
" 31 ...	204	460	250	....	....
Sept. 1 ...	204	375	248	....	....
" 2 ...	199	367	241	....	....
" 3 ...	160	375	233	....	....
" 4 ...	143	338	222	....	....
Average.	185	374	242		

The corresponding week in previous years has averaged, in second feet:

1881.....	—	1889.....	72	1895.....	335
1884.....	419	1890.....	166	1896.....	310
1885.....	352	1891.....	162	1897.....	227
1886.....	281	1892.....	—	1898.....	125
1887.....	289	1893(3 dys).	150	1899.....	374
1888.....	140	1894.....	174	1900.....	185

L. G. Carpenter,

Agricultural Ex. Station, Fort Collins, Colo., Sept. 4, 1900.

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No. 21. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

Sept. 5 to Sept. 11, 1900.

The flow of the river for the first three days of the week was slightly lower. Since then, rains in the mountains have increased the amount. The river rose quite suddenly from this cause on Sunday morning, from 130 feet to a maximum of 462 feet for a short time. Also, on Tuesday morning from 500 to 850 cubic feet.

The rainfall at the college during the week has been .63 inches, while the normal for the month is .79 inches. Rains in the valley have been of inestimable benefit to the whole community, especially to the farmers, after the long-continued dry weather of the past summer.

The normal river flow for next week is 172 cubic feet.

The following is the record for the week in second feet:

Date.	1900.	1899.	Normal	Highest	Lowest
Sept. 5 ...	133	317	210	....	....
" 6 ...	126	302	198	....	....
" 7 ...	124	289	198	....	....
" 8 ...	137	281	210	....	....
" 9 ...	183	263	206	....	....
" 10 ...	260	229	203	....	....
" 11 ...	255	214	200	....	....
Average.	174	271	204		

The corresponding week in previous years has averaged, in second feet:

1881.....	—	1889.....	65	1896.....	225
1884.....	359	1890.....	128	1896.....	293
1885.....	343	1891.....	138	1897.....	174
1886.....	224	1892..(est).	120	1898.....	86
1887.....	204	1893..(est).	160	1899.....	271
1888.....	121	1894.....	219	1900.....	174

L. G. Carpenter,
Agricultural Ex. Station, Fort Collins, Colo., Sept. 11, 1900.

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No. 22. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

Sept. 12 to Sept. 18, 1900.

The flow of the river has gradually fallen during the past week. The average for the week has been 144 cubic feet, while the normal for the same time is 172 cubic feet. The weather has continued dry, no precipitation having fallen at the college during the week Since May 1, the total precipitation has been 4.5 inches which is the dryest for these five months since 1893, when only 3.92 inches fell in that time.

The normal river flow for next week is 146 cubic feet.

The following is the record for the week in second feet:

DATE.	1900.	1899.	Normal	Highest	Lowest
Sept. 12 ...	151	200	192	....	....
" 13 ...	157	198	184	....	....
" 14 ...	156	202	171	....	....
" 15 ...	144	221	168	....	....
" 16 ...	138	223	170	....	....
" 17 ...	133	220	163	....	....
" 18 ...	126	198	154	....	....
Average.	144	209	172		

The corresponding week in previous years has averaged, in second feet:

1881.....	—	1889.....	66	1895.....	188
1884.....	309	1890.....	89	1896.....	305
1885.....	270	1891.....	129	1897.....	170
1886.....	177	1892..(est).	—	1898.....	65
1887.....	145	1893..(est).	—	1899.....	209
1888.....	160	1894.....	182	1900.....	144

L. G. CARPENTER,

Agricultural Ex. Station, Fort Collins, Colo., Sept. 18, 1900.

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No. 23. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

Sept. 19 to Sept. 25, 1900.

The flow of the river during the past week has remained about the same. The average for the week has been 120 cubic feet, while the normal for the same time is 140 cubic feet. The rainfall at the college during the week has been .33 inches. Light frosts have occurred since the 19th, but none sufficiently severe to kill the larger portion of growing crops.

The normal river flow for next week is 143 cubic feet.

The following is the record for the week in second feet:

Date.	1900.	1899.	Normal	Highest	Lowest
Sept. 19 ...	118	179	150	....	....
" 20 ...	113	154	149	....	....
" 21 ...	122	136	146	....	....
" 22 ...	122	141	142	....	....
" 23 ...	121	139	140	....	....
" 24 ...	121	138	146	....	....
" 25 ...	126	137	149	....	....
Average.	120	146	146		

The corresponding week in previous years has averaged, in second feet:

1881.....	—	1889.....	73	1896.....	205
1884.....	246	1890.....	82	1896.....	281
1885.....	219	1891.....	133	1897.....	149
1886.....	135	1892..(est).	120	1898.....	46
1887.....	134	1893..(est).	115	1899.....	146
1888.....	81	1894.....	119	1900.....	120

L. G. Carpenter,

Agricultural Ex. Station, Fort Collins, Colo., Sept. 26, 1900.

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No. 24. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

Sept. 26 to Oct. 2, 1900.

The river for the week shows a slight gain over the preceding week, a consequence of the storm which amounted to 1.28 inches. A small amount of water is still being received from the Laramie.

The rainfall in September amounted to 1.92 inches more than any other September on record since 1882.

The following is the record for the week in second feet:

Date.	1900.	1899.	Normal	Highest	Lowest
Sept. 26 ...	141	138	147	....	....
" 27 ...	144	135	148	....	....
" 28 ...	140	133	145	....	....
" 29 ...	140	130	143	....	....
" 30 ...	141	124	141	....	....
Oct. 1 ...	140	117	137	....	....
" 2 ...	137	108	138	....	....
Average.	140	126	143		

The corresponding week in previous years has averaged, in second feet:

1881.....	—	1889.....	70	1896.....	191
1884.....	283	1890.....	65	1896.....	176
1885.....	212	1891.....	147	1897.....	143
1886.....	138	1892..(est).	120	1898.....	33
1887.....	179	1893..(est).	160	1899.....	126
1888.....	85	1894.....	127	1900.....	140

The normal river flow for next week is 134 second feet.

L. G. Carpenter,

Agricultural Ex. Station, Fort Collins, Colo., Oct. 2, 1900.

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No. 25. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

Oct. 3 to Oct. 9, 1900.

The Poudre has remained nearly constant during the week, averagin 122 cubic feet per second for the whole week as against 101 for the same week last year, and 134 for the normal.

The corresponding week in previous years has averaged, in second feet:

1881	—	1889	66	1895	228
1884	203	1890	66	1896	212
1885	202	1891	134	1897	131
1886	133	1892..(est).	—	1898	41
1887	121	1893..(est).	—	1899	101
1888	97	1894	137	1900	122

L. G. CARPENTER,

Agricultural Ex. Station, Fort Collins, Colo., Oct. 9, 1900.

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No. 26. 1900

Special River Bulletin.

The Agricultural Experiment Station

FORT COLLINS, COLORADO.

Poudre River Bulletin.

Oct. 10 to Oct. 16, 1900.

The river for the week averaged 141 cubic feet per second, with a maximum of 165 feet on Thursday, and gradually dropped to 130 cubic feet at the end of the week. This is slightly above the normal.

The corresponding week in previous years has averaged, in second feet:

1881.....	—	1889.....	63	1895.....	180
1884.....	202	1890.....	93	1896.....	215
1885(11dys)	206	1891.....	112	1897.....	121
1886.....	123	1892..(est).	—	1898.....	63
1887.....	116	1893..(est).	—	1899.....	156
1888.....	100	1894.....	107	1900.....	141

L. G. CARPENTER,

Agricultural Ex. Station, Fort Collins, Colo., Oct. 17, 1900.

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TWENTY-SECOND ANNUAL REPORT

OF THE

State Board of Agriculture

COMPLIMENTS OF

THE STATE BOARD OF AGRICULTURE

1900

DENVER, COLORADO
THE SMITH-BROOKS PRINTING CO., STATE PRINTERS
1901

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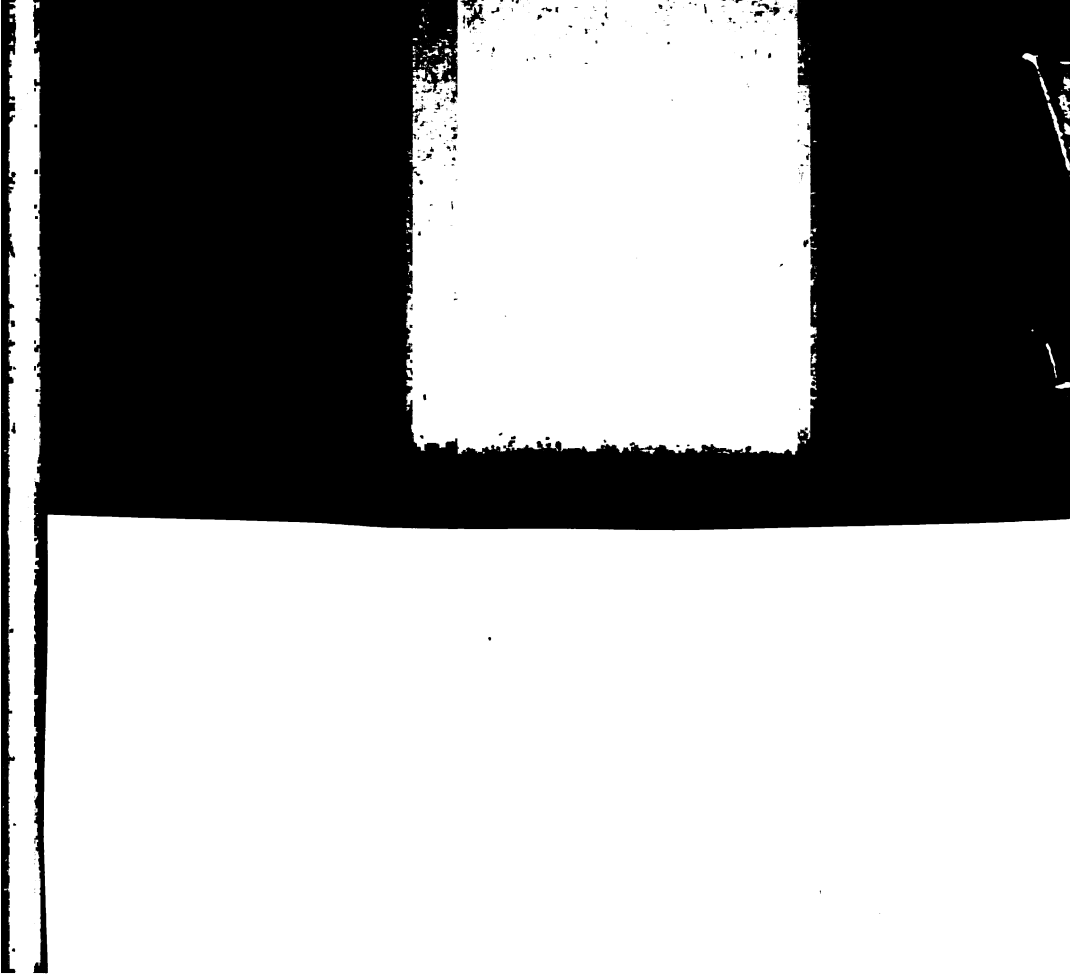

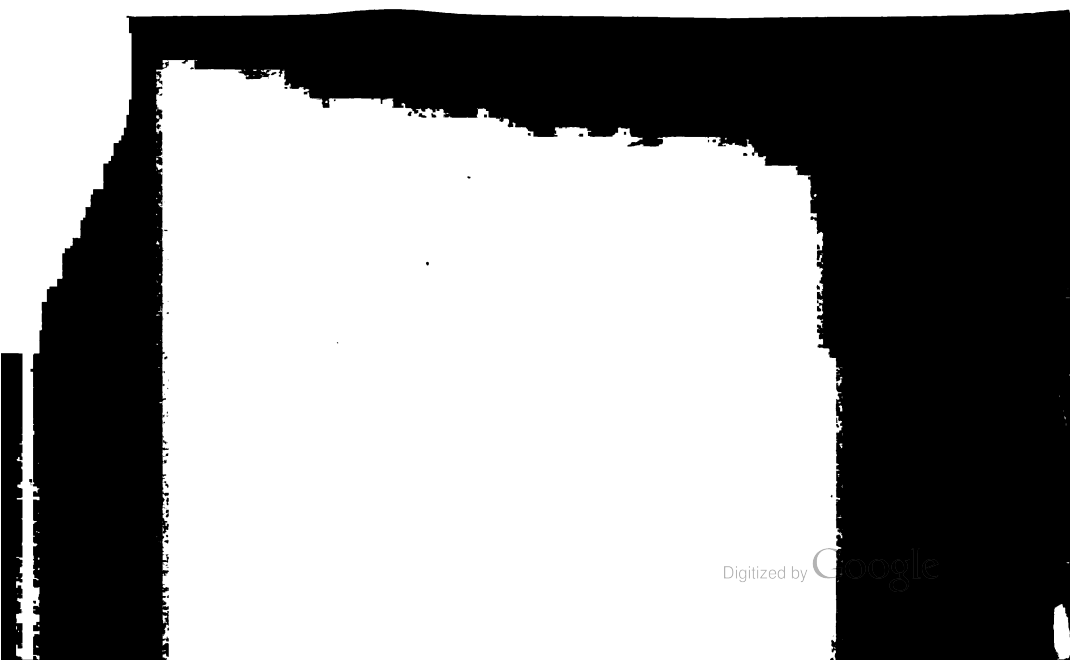

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TWENTY-SECOND ANNUAL REPORT

OF THE

State Board of Agriculture

AND THE

State Agricultural College

INCLUDING THE

THIRTEENTH ANNUAL REPORT

OF THE

AGRICULTURAL EXPERIMENT STATION

Fort Collins, Colorado

1900

DENVER, COLORADO
THE SMITH-BROOKS PRINTING CO., STATE PRINTERS
1901

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THE STATE BOARD OF AGRICULTURE

	Postoffice	Term Expires
HON. JAMES L. CHATFIELD	Gypsum	1901
HON. A. LINDSLEY KELLOGG	Rocky Ford	1901
HON. B. F. ROCKAFELLOW	Canon City	1903
MRS. ELIZA F. ROUTT	Denver	1903
HON. JESSE HARRIS	Fort Collins	1905
HON. P. F. SHARP	Denver	1905
HON. HARLAN THOMAS	Denver	1907
HON. P. A. AMISS	Pruden	1907
GOVERNOR C. S. THOMAS	*ex-officio.*	
PRESIDENT B. O. AYLESWORTH	*ex-officio.*	

OFFICERS.

P. F. SHARP	President
A. M. HAWLEY	Secretary
JOHN H. FESLER (State Treasurer, Denver, Colo.)	Treasurer
GEORGE A. WEBB	Local Treasurer

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STANDING COMMITTEES.

Executive.

P. F. SHARP JESSE HARRIS B. F. ROCKAFELLOW
J. L. CHATFIELD P. A. AMISS

Finance.

B. F. ROCKAFELLOW J. L. CHATFIELD A. L. KELLOGG

Farm and Stock.

J. L. CHATFIELD P. A. AMISS JESSE HARRIS

Faculty and Courses of Study.

B. O. AYLESWORTH HARLAN THOMAS ELIZA F. ROUTT

Botany, Horticulture and Entomology.

JESSE HARRIS B. F. ROCKAFELLOW P. A. AMISS

Mathematics, Civil and Irrigation Engineering and Military Science.

A. L. KELLOGG ELIZA F. ROUTT B. O. AYLESWORTH

Mechanical Engineering and Chemistry.

HARLAN THOMAS A. L. KELLOGG J. L. CHATFIELD

College Buildings and Permanent Improvements.

P. A. AMISS B. O. AYLESWORTH JESSE HARRIS

Domestic Science and Library.

ELIZA F. ROUTT HARLAN THOMAS B. F. ROCKAFELLOW

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THE AGRICULTURAL EXPERIMENT STATION.

STATION STAFF.

L. G. CARPENTER, M. S.....Meteorologist and Irrigation Engineer
C. P. GILLETTE, M. S.....Entomologist
W. W. COOKE, B. S., A. M.....Agriculturist
W. P. HEADDEN, A. M., PH. D.....Chemist
J. H. COWEN, B. S., M. AGR.*.....Horticulturist and Botanist
R. E. TRIMBLE, B. S.....Assistant Meteorologist and Irrigation Engineer
F. L. WATROUS.....Assistant Agriculturist
L. A. TEST, B. M. E., A. C.....Assistant Chemist
E. D. BALL, M. S.....Assistant Entomologist
C. H. POTTER, M. S.....Assistant Horticulturist
JOSEPH LOWNES, B. S.....Assistant Chemist
F. C. ALFORD, B. S.....Assistant Chemist
H. H. GRIFFIN, B. S....Superintendent Arkansas Valley Substation, Rocky Ford, Colorado
J. E. PAYNE, M. S.....Superintendent Plains Substation, Cheyenne Wells, Colorado

OFFICERS.

PRESIDENT, B. O. AYLESWORTH, A. M., LL. D.
L. G. CARPENTER, M. S.....Director
A. M. HAWLEY.....Secretary
W. R. HEADDEN, B. S.....Stenographer and Clerk

*Elected July 2, 1900. Died July 12, 1900.

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BOARD OF INSTRUCTION.

BARTON O. AYLESWORTH, A. M., LL. D.,
President and Professor of Political Economy and Logic.

JAMES W. LAWRENCE, B. S.,
Professor of Mechanical Engineering.

LOUIS G. CARPENTER, M. S.,
Professor of Civil and Irrigation Engineering.

WENDELL PADDOCK, M. S.,
Professor of Botany and Horticulture.

CLARENCE P. GILLETTE, B. S.,
Professor of Zoology and Entomology.

BURT C. BUFFUM, M. S.,
Professor of Agriculture.

WILLIAM P. HEADDEN, A. M., Ph. D.,
Professor of Chemistry and Geology.

THEODOSIA G. AMMONS,
Professor of Domestic Science.

EDWARD B. HOUSE, B. S., E. E.,
Professor of Mathematics.

EDWARD M. TRABER, A. B.,
Professor of Rhetoric and Philosophy.

VIRGINIA H. CORBETT, B. S.

ALFRED M. HAWLEY,
Secretary of the Faculty.

CHARLES J. GILKISON, B. S.,
Principal Commercial Department.

RICHARD A. MAXFIELD, B. S., Major Cadet Battalion,
Professor Military Science and Tactics.

DR. GEO. H. GLOVER, B. S., D. V. S.,
Professor of Veterinary Science and Surgery.

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INSTRUCTORS AND ASSISTANTS.

R. E. TRIMBLE, B. S., Meteorology and Irrigation Engineering.
AMOS JONES, B. S., Field Work in Engineering.
L. D. CRAIN, B. M. E., Mechanical Engineering.
ALLEN P. GREENACRE, B. S., Forge-Room Work.
WILLIAM F. GARBE, Foundry Practice.
FRANK L. WATROUS, Agriculture.
CARL H. POTTER, M. S., Botany and Horticulture.
CHARLES F. MERGLEMAN, Floriculture and Landscape Gardening.
LOUIS A. TEST, B. M. E., A. C., Chemistry.
FRED ALFORD, B. S., Chemistry.
JOSEPH LOWNES, B. S., Chemistry.
E. S. G. TITUS, B. S., Entomology.
LATHROP M. TAYLOR, B. S., Stenography and Typewriting.
CHARLES GOLDING-DWYRE, Jr., Bookkeeping.
RALPH H. HESS, B. S., Mathematics.
SARAH T. SUTHERLAND, Domestic Science.
JAMES A. STUMP, B. S., Physics and Civil Engineering.

Librarian:
MARGUERITE E. STRATTON, B. S.

Stenographer, President's Office:
FRANK H. THOMPSON, B. S.

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LETTER OF TRANSMITTAL.

To His Excellency, The Governor:

Sir—Herewith I transmit my annual report as secretary of the State Board of Agriculture. It is respectfully commended to your attention and to the thoughtful consideration of the general assembly.

A. M. HAWLEY,
Secretary, the State Board of Agriculture.

THE STATE AGRICULTURAL COLLEGE,
Fort Collins, Colorado,
November 30, 1900.

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SECRETARY'S STATEMENT

CONNECTED WITH THE GENERAL FUND.

FOR THE FISCAL YEAR, BEGUN DECEMBER 1, 1899, AND ENDED NOVEMBER 30, 1900.

RECEIPTS.

Land income fund (congressional act of 1862 for the endowment of an Agricultural College in Colorado)	$10,913 09	
Tax fund, one-fifth mill levy	32,945 99	
Annie Jones library fund	18 00	
		$43,877 08

DISBURSEMENTS.

Salaries	$ 8,053 23
President's office	269 99
Secretary's office	189 70
Library department	466 69
Horticultural department	3,031 39
Agricultural department	7,620 72
Chemical department	1,470 17
Mechanical engineering department	1,511 11
Mathematical department	63 10
Physics and engineering department	717 09
Zoology and entomology department	567 15
Military department	26 25
History and literature department	16 60
English and philosophy	38 60
Domestic science department	418 99
Commercial department	274 92
Furniture	108 80
Insurance	914 25
Current expense	3,508 68

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DISBURSEMENTS—Continued.

State Board of Agriculture	2,734 00	
General repairs	1,448 21	
Permanent improvements	1,540 20	
Text-book department	2,066 38	
Freight and express	398 99	
Fuel and lights	3,169 89	
Student labor	1,771 57	
Veterinary science department	204 55	
Advertising	447 09	
Farmers' institutes	189 77	
Annual catalogue	625 00	
Association of A. A. C. and E. S	10 00	
		$43,877 08

ITEMIZED STATEMENT OF SECRETARY'S CASH RECEIPTS.

Farm department sales	$ 1,369 47	
Text-book department sales	1,290 31	
Domestic science department sales	7 39	
Horticultural department sales	196 12	
Freight, etc., refunded	60 35	
Commercial department sales	75	
Entomological department sales	22 05	
President's office sales	4 00	
Engineering department sales	21 05	
Chemical department sales	45 00	
Annie Jones library fund	84 95	
		$ 3,101 44

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REPORT OF THE UNITED STATES OR "MORRILL" FUND FOR THE FISCAL YEAR BEGUN JULY 1, 1899, AND ENDED JUNE 30, 1900.

RECEIPTS.

Balance on hand July 1, 1899	$ 390 85	
United States draft	25,000 00	
		$25,390 85

DISBURSEMENTS.

Salaries	$25,390 85

REPORT OF EXPERIMENT STATION FUND (ACT OF CONGRESS OF 1887) FOR FISCAL YEAR BEGUN JULY 1, 1899, AND ENDED JUNE 30, 1900.

RECEIPTS.

United States draft	$15,000 00	
		$15,000 00

DISBURSEMENTS.

Salaries	$ 8,797 80	
Agricultural section	89 48	
Horticultural section	162 10	
Entomological section	229 07	
Chemical section	1,000 00	
Meteorology and irrigation section	856 38	
Director's office	283 03	
Printing bulletins	291 65	
Stationery	32 35	
Arkansas valley sub-station	1,835 72	
Plains sub-station	1,104 67	
Annual report	297 00	
A. A. A. C. and E. S.	10 00	
Library	10 75	
		$15,000 00

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REPORT OF EXPERIMENT STATION SPECIAL FUND FOR FISCAL YEAR BEGUN JULY 1, 1899, AND ENDED JUNE 30, 1900.

RECEIPTS.

Balance on hand July 1, 1899	$ 391 69	
Arkansas valley sub-station sales	1,079 87	
Irrigation section sales	5 00	
Horticultural section sales	8 35	
Divide sub-station rent	40 00	
		$ 1,524 91

DISBURSEMENTS.

San Luis valley sub-station	$ 150 00	
Arkansas valley sub-station	147 89	
Divide sub-station	6 80	
Salaries	175 46	
Agricultural section	20 00	
Horticultural section	2 25	
Entomological section	14 93	
Irrigation section	106 50	
Printing bulletins	316 85	
Stationery	4 50	
Plains sub-station	137 51	
Director's office	124 75	
		$ 1,207 44
Balance on hand with local treasurer, July 1, 1900		$ 317 47

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PRESIDENT'S REPORT.

To the State Board of Agriculture:

STUDENT ENROLLMENT.

The student enrollment for the year 1899-1900, given by classes, is as follows:

	Male.	Female.	Total.
Post graduates	6	1	7
Seniors	20	10	30
Juniors	24	4	28
Sophomores	22	10	32
Freshmen	48	16	64
Sub-freshmen	53	25	78
Preparatory class	21	9	30
Commercial course (seniors)	6	9	15
Commercial course (juniors)	36	20	56
Unclassified students	8	15	23
Total	244	119	363

It will be observed, from the above list of registration, that the gain of 1899 over 1898 in enrollment is considerable; in fact, it is the largest for a number of years. The registration has been fairly apportioned among the five courses, viz.: agricultural, mechanical engineering, civil engineering, ladies', and commercial.

It was thought best by the board last year, the entire faculty concurring, to drop the preparatory year from the course of study. There are various reasons for this action. Since it did the work of the eighth grade, it was, in reality, duplicating the work already done at public expense in every portion of the state. Then, too, the law prescribing the qualifi-

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cations for admission seems very clearly to prohibit work below the present sub-freshman year.

There may have been a slight fear as to the effect this loss would have upon the enrollment. Such fear, however, disappears in the light of the registration of the fall term and first month of the winter term of this year, as shown in the following classification:

	Male.	Female.	Total.
Seniors	21	2	23
Juniors	18	9	27
Sophomores	42	13	55
Freshmen	47	24	71
Sub-freshmen	75	15	90
Senior commercials	7	7	14
Junior commercials	44	18	62
Unclassified students	6	18	24
Post-graduates	1	..	1
Total	..	..	367

The loss resulting from the dropping of the preparatory year has been made good, and prospects are excellent for a considerable net gain before the end of the college year.

But something more than numbers appears here. Numbers, after all, is a minor per cent. as indicating the growth of an institution. The increase in the average age of the students, the general bearing of the student body, the more serious work, and the finer spirit manifested at the daily task are surer marks of growth.

In the list of the faculty appear four new names. These new workers came to us at the beginning of the present school year. Their predecessors resigned to accept other positions, two of them to go into the government employ in scientific research—with the best of good will towards board, faculty and students. In filling their places, a most thorough canvass was made of all the available material. None but those in closest sympathy with agricultural and mechanical education was considered. It is gratifying to state that the results have proved entirely satisfactory. Prof. B. C. Buffum was called to the chair of agriculture, so long occupied by Prof. W. W. Cooke. Prof. Buffum was vice-director of the station and agriculturist in the Wyoming University for nine years.

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Prof. Wendell Paddock, an alumnus of the Agricultural College of Michigan and eight years assistant horticulturist at Geneva, New York, was called to succeed Prof. C. S. Crandall as botanist and horticulturist. Miss Virginia H. Corbett, a graduate of the State Agricultural College of Iowa, was called to the chair of history and literature. Miss Corbett held a similar position in Iowa and Montana. Mr. James A. Stump succeeds Mr. Jay D. Stannard as first assistant in the department of civil engineering. Mr. C. J. Griffith, of the Iowa State College, has been called as assistant in dairying to Mr. Buffum.

Two successes in particular mark the year 1899, viz.: the increased service and efficiency of the experiment station, under the directorship of Prof. L. G. Carpenter, and the revival of the interest in farmers' institutes throughout the state. Still better things are to be done in the line of institute work during the coming season.

The experiment station has added largely to its mailing list; has put itself in touch with similar work throughout the world, and has taken an exalted place among the experiment stations of the nation. It sees its unparalleled opportunity.

Under the leadership of Prof. B. C. Buffum, the agricultural side of the college is receiving the attention due it. The board and faculty have a fixed purpose to make this department increasingly the most important department of the college. The agricultural department has been reinstated in its own building, the Agricultural Hall. The building has been renovated, beautified and made ready for increased work.

The stock yards are being rebuilt upon modern plans.

The fine herd of Durham cattle purchased last spring is but the beginning of a larger education in the stock enterprise for the promotion of the stock industry of the state.

Last year the college buildings were repainted and put in general repair. This year general improvements are being made upon and around the grounds. Much needed stone walks are being laid, fences are being builded, and the drives about the buildings are being graveled.

Not one dollar, however, has been or is being expended, except as it is absolutely needed for the preservation of property and the comfort of teachers and students.

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Much of the excellent spirit of the school is due to the sympathy controlling the college athletics. No innovations have been introduced. An honest effort has been made to have the Colorado Agricultural College a modern school in method, work and spirit.

A fruitless orchard—long condemned by the State Board of Agriculture and a standing shame to all those connected with the school—was ordered removed by the board. This has been easily converted into an athletic field. It is one of the best in the West. Here, with the same honor, obedience and spirit with which all college work is done, young men, under faculty control, take such physical exercise as health, hard study and modern college ideas admit.

Aside from the requirements of athletics, such a field was absolutely necessary for drilling purposes. On account of this advantage, the instructor in military tactics has been able to put his battalion in such condition as to make it the pride of the state.

I desire to recommend as an experiment a series of short courses along special lines, such as dairying, beekeeping, poultry raising, irrigation and measurement of water for ditch riders and water commissioners.

By close economy the State Board of Agriculture has kept the college running during the past year without special appropriations and without incurring any indebtedness. But so rapidly are the agricultural, horticultural and stock interests of the state growing that as soon as possible special appropriations should be voted by the legislature for at least one new building, for a better equipment for the civil engineering department, and for a barn adequate to the needs of a great school in a great state. I think for the present need $10,000 would give us adequate accommodation for our valuable and increasing herds and an increase of our fund for student labor. A small appropriation for the extension of farmers' institutes in the state would be an exceedingly wise and timely action.

Neither the library nor museum is properly housed. The auditorium is too small for the number of students enrolled.

The board and faculty ask merely that as the state grows in numbers, wealth and industries, its educational institutions be permitted to grow in the same ratio.

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NAMES OF INSTRUCTORS AND REGULAR EMPLOYES, WITH THEIR ANNUAL SALARIES.

ALSO A STATEMENT OF THE FUND OR FUNDS WHENCE SUCH SALARIES ARE DRAWN.

FACULTY.	College Fund.	Station Fund.
BARTON O. AYLESWORTH, A. M., LL.D., president and professor of logic and political economy	$ 5,000	.....
JAMES W. LAWRENCE, B. S., professor of mechanical engineering	2,000	.....
LOUIS G. CARPENTER, M. S., professor of civil and irrigation engineering	2,000	$ 900
CLARENCE P. GILLETTE, M. S., professor of zoology and entomology	1,500	500
WILLIAM P. HEADDEN, A. M., Ph.D., professor of chemistry and geology	1,500	500
THEODOSIA G. AMMONS, professor of domestic science	1,500	.....
EDWARD B. HOUSE, B. S., E. E., professor of mathematics	1,500	.....
EDWARD M. TRABER, A. B., professor of rhetoric and philosophy	1,500	.....
ALFRED M. HAWLEY, secretary of the faculty	1,000	500
CHARLES J. GILKISON, B. S., principal commercial department	1,500	.....
BURT C. BUFFUM, M. S., professor of agriculture	1,500	500
VIRGINIA H. CORBETT, B. L., professor of history and literature	1,500	.....
WENDELL PADDOCK, M. S., professor of botany and horticulture	1,500	500
RICHARD A. MAXFIELD, B. S., major cadet battalion, professor military science and tactics, and assistant in mathematics	700	.....
STENOGRAPHERS.		
FRANK H. THOMPSON, B. S.	1,000	.....
WILLIAM R. HEADDEN, B. S.	.....	600
LIBRARIAN.		
MARGUERITE E. STRATTON, B. S.	700	.....

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ASSISTANTS.	College Fund.	Station Fund.
JAMES A. STUMP, B. S., physics and civil engineering	1,000	.....
ROBERT E. TRIMBLE, B. S., meteorology and irrigation engineering	.....	1,000
L. D. CRAIN, B. M. E., mechanical engineering and drawing	1,000	.....
ALLEN P. GREENACRE, B. S., forge room work	600	.....
WILLIAM F. GARBE, foundry practice	720	.....
FRANK L. WATROUS, agriculture	.....	1,000
EDWARD S. G. TITUS, B. S., entomology	204	396
CARL H. POTTER, M. S., botany and horticulture	400	600
CHARLES F. MERGELMAN, floriculture and landscape gardening	900	.....
LOUIS A. TEST, B. M. E., A. C., chemistry	600	400
FRED ALFORD	.....	600
JOSEPH LOWNES, B. S., chemistry	.....	600
LATHROP M. TAYLOR, B. S., stenography and typewriting	1,000	.....
CHARLES G. DWYRE, JR., bookkeeping	750	.....
SARAH T. SUTHERLAND, domestic science	750	.....
RALPH H. HESS, B. S., mathematics	750	.....
AMOS JONES, B. S., field work in engineering	600	.....
C. J. GRIFFITH, B. S., dairying	800	.....
SUB-STATION SUPERINTENDENTS.		
HARVEY H. GRIFFIN, B. S., Arkansas valley, Rocky Ford, Colorado	.....	900
J. E. PAYNE, M. S., rainbelt, Cheyenne Wells, Colorado	.....	800
ENGINEERS AND JANITORS.		
WILLIAM KELLY	780	.....
JOHN H. CAMERON	600	.....
JAMES L. VEAZEY	600	.....
ISAAC N. CHATFIELD	600	.....
LABORERS REGULARLY EMPLOYED.		
J. H. CAMERON, JR.	540	.....
ALVIN FRY	540	.....
FRANK MATTHEWS	540	.....
N. C. STRAYER	540	.....
ROBERT WALKER	480	.....
Total	$41,294	$10,296

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GENERAL.	College Fund.	Station Fund.
Station labor	.....	$ 2,436
College labor	$ 525	.....
Student labor	1,771	.....
Total	$ 2,296	$ 2,436

SUMMARY.

Salaries	$41,294	$10,296
Labor	2,296	2,436
Grand total	$43,590	$12,732

SUMMARY OF COLLEGE INVENTORIES.

NOVEMBER 30, 1900.

LANDS AND ADJUNCTS.

Two hundred and forty (240) acres of land at an average value of $100 per acre	$ 24,000 00	
*Trunk sewer to Poudre river	6,000 00	
Pipe line for water supply	2,900 00	
		$ 32,900 00

BUILDINGS, INCLUDING PERMANENT FIXTURES.

Main college building	$ 36,000 00
Mechanical engineering building	23,000 00
Agricultural hall and creamery	10,500 00
Horticultural hall	15,100 00
Civil engineering building	9,000 00
Commercial college building	6,000 00
Chemical laboratory	27,000 00
Building for department domestic science	4,650 00

*This estimate includes numerous sewer laterals and water connections; a reservoir for storage of water; all other improvements of the college grounds, and ditch stock worth $2,000.

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BUILDINGS, INCLUDING PERMANENT FIXTURES—Continued.

Green houses ($3,000) and forcing house ($1,500)	4,500 00	
Barns, tool house and sheds on horticultural grounds	2,299 00	
Barn on college farm	4,000 00	
Sheep barn and paddocks ($600), implement house and shed ($450), pig pens ($300), other stock pens ($350), root cellar and silo ($250), fencing ($1,450) on college farm	3,400 00	
Farm dwelling house	2,700 00	
Depot, hose house and apiary	700 00	
	$148,849 00	
Grand total		$181,749 00

DEPARTMENT INVENTORIES.

History and literature	$ 408 50	
Rhetoric and philosophy	359 94	
Mathematics	582 80	
Military science and tactics	7,465 85	
Zoology and entomology	5,858 55	
Agriculture	9,492 63	
Botany and horticulture	6,673 02	
Engineering and physics	11,267 44	
Chemistry	3,827 75	
Domestic science	1,280 50	
Commercial department	2,133 92	
Mechanical engineering and drawing	15,044 65	
		$ 64,345 55

MISCELLANEOUS.

President's office, No. 1	2,577 20	
President's office, No. 2	2,037 50	
Secretary's office	510 70	
Library	10,376 78	
	$ 15,502 18	
Total of college property		$246,094 55
Total of station property		27,892 65
Grand total of all property		$273,987 20

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INVENTORY.

DIRECTOR'S OFFICE.

Office fixtures and equipment	$ 420 80	
Stationery supplies	197 60	
Half tones, zinc etchings and photographs	200 00	
Bulletin library	500 00	
		$ 1,317 90

AGRICULTURAL SECTION.

Implements and tools	$ 56 00	
Office equipment and miscellaneous	386 00	
		$ 442 00

ENTOMOLOGICAL SECTION.

Laboratory supplies	$ 73 95	
Entomological supplies	70 85	
Insecticides and insecticide apparatus	86 05	
Apiary	152 10	
In charge (microscope, etc.)	310 00	
		$ 692 95

HORTICULTURAL SECTION.

Glassware	$ 6 74	
Photographic apparatus and supplies	84 95	
Instruments	43 00	
Trees and nursery stock	294 10	
Herbarium	1,560 00	
Miscellaneous	1 25	
		$ 1,990 04

METEOROLOGICAL AND IRRIGATION ENGINEERING SECTION.

Meteorological instruments	$ 545 15	
Office fixtures	34 00	
Stationery, books, maps, etc	32 60	
Irrigation and hydraulic apparatus	236 35	
Photographic supplies and negatives	146 95	
Miscellaneous	146 31	
		$ 1,141 36
Library		$ 1,100 00
Total main station		$ 6,684 25

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ARKANSAS VALLEY SUB-STATION.

Water rights and apparatus	$ 1,836 00	
Fences, gates and bridges	338 30	
Buildings and improvements	2,010 00	
Live stock	181 00	
Implements and tools	393 15	
Miscellaneous	54 50	
Farm produce on hand	1,068 75	
		$ 5,881 70

PLAINS SUB-STATION.

Buildings and improvements	$ 930 00	
Two horses	75 00	
Implements	127 95	
Apparatus	152 10	
Supplies and farm products	73 50	
		$ 1,358 55

SUB-STATION AT MONTE VISTA.

Buildings, fencing, etc	$ 1,497 00	
One team horses	150 00	
Windmill and appliances	150 00	
Farm implements	82 15	
		$ 1,879 15

SUB-STATION AT THE DIVIDE.

Buildings	$ 729 00	
Forty acres of land	200 00	
		$ 929 00
Total sub-station property		$10,043 40
Total main station property		6,684 25
Total experiment station property		$16,732 65

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In addition the station has the use and control of other property as long as used for experiment station purposes, as follows:

160 acres of land at Cheyenne Wells	$	160 00
200 acres of farm and fruit land at Arkansas valley sub-station		11,000 00
		$11,160 00

I submit the department reports herewith for the year ended December 12, 1900.

BARTON O. AYLESWORTH,
President.

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REPORT OF THE DEPARTMENT OF AGRICULTURE.

TO THE STATE BOARD OF AGRICULTURE:

I herewith transmit the annual report of the department of agriculture to the State Board of Agriculture for the fiscal year ending December 1, 1900.

The relation of this department to the college is a peculiarly close one. While one department can hardly be said to be more important than another, where all are essential to the making up of the complete organization, yet it pleases me to think of the agricultural department as the mainstay of the college; as the principal reason, if you will, of our existing as an institution. The history of agriculture in the college since its inception would be interesting. During the first decade Prof. A. E. Blount, filling the chair, was the man who brought this phase of the work into prominence, who gave the department an enviable reputation which was world-wide, who left his stamp upon the agriculture of the state in the valuable wheats which he originated, whose painstaking care and whole-hearted interest left a lasting influence on the students who were near to him. Then came Prof. W. J. Quick, who laid out the farm, with its present system of drives, introduced fine stock with the first noted Shorthorn cattle, and secured the erection of present Agricultural Hall and farm cottage. For the past seven years the chair has been filled by Prof. W. W. Cooke, who, among other things, established a dairy herd of Jerseys, and the present equipment for teaching dairying to the continually increasing number of students who are interested in this branch of husbandry.

Since September 1 of the present year the time has been too short to enable your present incumbent to report very much work accomplished or to give an adequate idea of the facilities for teaching and the rare opportunity offered the student for up-to-date instruction in the science and art of agriculture as applied to the peculiar conditions of the irrigated West. Through the present awakening in agriculture and the determination of President Aylesworth to make and

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keep this institution second to none other of its kind, and the careful management of the board, there is a most healthy growth and improvement. While the student of the past has had most wholesome food, the student of the coming years will find better material and facilities than ever before.

Equipment—The college farm, with its equipment of lands, machinery and live stock, is all considered laboratory material for the student. Along with the theory, given by the lecture and the library, goes the demonstration of the art in the laboratory, where the student may become acquainted with up-to-date implements and machines, with soils and crops, with breeds of live stock and the peculiar merits of individuals in each breed. The inventories of November 1 show live stock on the farm to the value of about seven thousand dollars. During the coming year additional breeds will be added. The farm itself presents a variety of conditions such as may be found on farms in different parts of the state. There is a system of ditches to supply water, various conditions of slope of the land to be irrigated, waste land which has been reclaimed and is being reclaimed by systems of drainage, alkali lands to be made productive, native pasture tracts, old lake bed reclaimed and converted into meadow, alfalfa fields and plowed lands. Connected with the work of the farm is the work of the experiment station, in which the student has opportunity to study methods and purposes of investigation.

Classes are accommodated in the classroom in Agricultural Hall, and students have free access to the department library, which has been placed in the same building. A combined office and reading room affords students a place where it is profitable to spend their spare hours. Here, also, is the laboratory for dairy work, with equipment for testing milk, separating and handling milk and cream and making butter. Adjoining the office is a convenient dark room for photographic work. The photographing done so far has been principally of live stock for illustrating and as matter of record. As fast as possible illustrations will be made for class instruction.

Assistants—Until recently there has been but one assistant. On October 1, Mr. C. J. Griffith was employed as assistant in dairying and animal husbandry. Mr. Griffith is a graduate of the Iowa Agricultural College, where he was assistant in dairying for one year before coming to us. He has

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won several prizes on butter in exhibitions, is thoroughly acquainted with live stock, and is an investigator along these lines. Moreover, he has proved to be a strong teacher, leading and enthusing the student. Mr. Griffith aids in teaching dairying, the breeds of live stock, and judging.

Mr. Frank Watrous is the experiment station assistant. Not only has he successfully carried on this part of the work, but he has had general management of the farm for many years. On account of being actively engaged in farming and stock raising for himself, he has resigned the assistantship, to take effect January 1, 1901. This necessitates the selection of a new man for the place, and I would suggest the advisability of separating the general farm management from the list of duties of the station assistant. In a place of this kind so many investigations are going on, requiring detailed management and continual oversight, the taking of scientific notes, which must be systematically arranged and properly recorded, along with the many duties of such an assistant, that he cannot properly manage a large farm and do the more technical work at the same time.

Work Done—During the fall term my classroom work consisted of a freshman class in beginning agriculture, in which thirty-one students were enrolled; a junior class in stock feeding, containing seven students, and a senior class of three students in dairying. The class in dairying had one hour class work in the morning through the term and two hours laboratory work in the afternoon during the first two-fifths of the term. This class was taken by Mr. Griffith after the beginning of October. The text book in beginning agriculture was changed this year, Bailey's "Principles of Agriculture" now being used. In addition to the text each member of the class was required to keep a note book, in which was recorded various additions and observations. The subject is presented in the form of a nature study in agriculture, taking up the first principles, different branches of agriculture, soils, tillage, seedage and propagation, soil fertility and rotation and elements of stock raising and feeding. The text book used by the class in stock feeding was also changed, adopting Henry's "Feeds and Feeding." It is impossible to cover so large a book in one term, so the student was given the principles of feeding, digestion and digestion experiments, different classes of foods, feeding standards and the computations of farm rations. The members of the class, without

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exception, voluntarily took up the extra work of carrying out a feeding experiment. Because of their quick maturity, the present interest in raising them and the fact that feeding these animals has never been systematically investigated, Belgian hares were selected for the experiment. Twenty-seven rabbits were diveded into lots, and nine different rations fed for a period of five weeks. The experiment was carefully and conscientiously carried out by every student, who kept a complete note book of the trial. At the close of the experiment the animals were all slaughtered and examined, and a series of photographs made to show the comparative effect on the body of the different foods. I have recommended its publication by the station.

The senior class in dairying used as text books Gurler's "American Dairying;" Farrington and Woll, "Testing Milk," and Wing's "Milk and its Products." The last part of the term Mr. Griffith also gave them a series of lectures on the principles of cheese making. Teaching these classes has been doubly pleasant, because of the earnestness and interest of the students, who have not only put in the required time, but all the extra time they could spare. If found feasible, I would recommend such rearrangement and adjustment of the course that agricultural students are able to take laboratory work in agriculture two hours per day for at least one year, including the dairying, and that all agricultural students be given the principles of chemistry at least as early as the sophomore year.

In addition to the teaching, some station work has been in progress, with grains and feeding, and some general improvements have been made in the department. The Agricultural Hall was thoroughly renovated inside and out, and many improvements have been and are still under way on the farm. The greatest need of the department is more stable room for the fine stock on hand and a greater variety of the standard breeds. We should have an up-to-date stock barn, with all modern improvements. Colorado has always been proud to offer her youth every educational facility in her state institutions. There has been such activity in other states in building up the agricultural departments in their colleges that if Colorado would continue to lead the states in the inter-mountain region, the coming session of the legislature must come to the support of this department. This is a matter in which every farmer of the state should take interest

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and pride. The large influx of students shows their confidence and faith, and an understanding of our needs, compared with the needs and provisions to meet them in other states, would secure that small support which would put us many steps in advance of our present condition. The present management is doing everything possible to maintain a high standard of excellence and develop that side of the institution which is of greatest value to our agricultural interests. For several years such support was withheld from the agricultural department, so it has not shown the growth it should.

I wish to thank those who are co-operating in a renewed effort to build up this important work.

Respectfully submitted,

B. C. BUFFUM,
Professor of Agriculture.

December 12, 1900.

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REPORT OF THE DEPARTMENT OF CIVIL AND IRRIGATION ENGINEERING.

TO THE STATE BOARD OF AGRICULTURE:

I have the honor to present the report of this department for the year since your last annual meeting.

The classes in this department are the same as have been carried on for some years past. These include physics, for three terms in the sophomore and junior years; surveying, in the third term of the sophomore year; irrigation engineering; higher surveying, draughting, in the junior and senior years of the engineering course; meteorology for one-half term, some juniors and some seniors; reservoirs and dams, a course of lectures to the seniors; strength of materials, to the seniors of both engineering courses; trusses and bridges; and hydraulics. These constitute the classroom work of the forenoon. In addition there is a large amount of laboratory work. It is often the case that some of the classes have to be divided into two or more sections for laboratory practice. In scientific instruction, especially that in the laboratories, six to ten students are as many as one instructor can profitably instruct at one time. The classes in laboratory work include those in physical laboratory (in two or three sections) for each of the three terms of the year; in surveying, the sophomores for one-half term, the juniors in field work during the winter term, and the seniors in field work during the fall term; and the senior class of both engineering courses in testing materials for two-fifths of the winter term.

There has been a distinct improvement during the past year in the work done by the students.

The principal change which has been instituted during the past season has been in the field work. In a previous report attention has been called to the need of more extended field practice for the engineering students, and the advisability of camping trips for that purpose has been urged. It was pointed out that such instruction could be made more effective and serious, and greater in quantity and value, if the time

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continuously devoted to instruction were longer, and the conditions more like those which would come up in practice. In the fall term a trial was made, with the consent of President Aylesworth. Both the juniors and seniors in the engineering course were allowed two weeks, which time was devoted to a trip to the mountains. The party moved at once to an elevation of more than 9,000 feet to a good camping spot, adjacent to fairly smooth and to exceedingly rough country. The site chosen was near the foot of Long's peak. Lines were run by different members of the party, both by transit and level, up the flanks of the peak, and were carried from an elevation of less than 8,000 feet up to an elevation of 12,000 feet. The students bore the expense involved in sustenance and transportation; the cost being but little more than would have been involved in remaining in town. The college was at the expense of the permanent outfit, and also arranged for the tents and cooking utensils. The result of the expedition was extremely valuable, and justifies making this a permanent feature of the course for the students in engineering. It will doubtless be better to make the trip earlier in the term than was done the past season. It will be possible in future years, as it will then be known in advance that such a trip will be taken.

HYDRAULIC AND ENGINEERING BUILDING.

At the June meeting reference was made to the need of certain hydraulic apparatus and a new building, and authority was given for the construction of a flume for rating meters. A recommendation was also made looking toward a building for that purpose. In case such a building is possible the rating flume should be connected with it. In view of that possibility the construction of the flume was postponed. An examination of the building now occupied will show that the department has outgrown its quarters. The building, which was originally built for a dormitory, has been of great use, but the pressure for more room has been felt for some years. As the needs of other departments were recognized as being greater than ours, the matter has not been urged. At present, however, it seems not unreasonable to urge the claims of this department upon the board. It is proper to say that on account of the small room it has not been possible to give systematic laboratory work either in hydraulics or in engineering. In some respects this has been compen-

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sated by exceptional opportunities in the neighborhood, but such opportunities do not take the place of a laboratory for such instruction, especially in the elementary work. Moreover, when this building was assigned, the department was better situated than the corresponding ones in our neighboring colleges. This is not now the case. The importance of irrigation at present and in the future in this state justifies that special facilities be given along this line.

LABORATORY INSTRUCTION IN THE EAST.

The attendance at the Association of American Agricultural Colleges and Experiment Stations, at New Haven, was made the opportunity to visit the hydraulic laboratories of many of the institutions which are now giving instruction along this line. There are now some excellent laboratories of this kind. Those of the Massachusetts Institute of Technology, the Worcester Technological Institute, of the proprietors of locks and canals at Lowell, Mass., and Cornell University were visited.

The collegiate institutions have a double purpose—the instruction of the student and investigation, which is looked on as an important function of a university. Accordingly, there is sometimes, as at Worcester and Cornell, a double plant—one for the instruction of undergraduate students; the other for mature students or postgraduates, or mayhap for important investigations. At Lowell the conditions, which arise from the necessity of dividing a varying quantity of water, have developed the necessity of experiments which, in their completeness and refinement, have become classical.

Cornell University, on a commanding place on the banks of Cayuga Lake, has utilized a deep gorge in the campus by building a dam and erecting a stone structure with elaborate accessories, so that the institution expects not only to aid serious investigators, but to be the site for investigations needed by the hydraulic interests of the state. With them, the questions largely pertain to navigation canals, water works and sewage systems for towns, etc.

Without describing these systems at this time, the suggestive lesson derived from them is the importance of adapting such work to the conditions. The Cornell hydraulic laboratory, important as it is, nor one on the same plan, is not adapted to settle our questions, which grow from the con-

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nection here of hydraulics with irrigation. Some institution so prepared as to take up the question on a suitable scale could be of great service to the West.

A SHORT COURSE FOR CANAL SUPERINTENDENTS, WATER COMMISSIONERS, ETC.

The usefulness of short courses in their particular field has been shown by the experience of various agricultural colleges which have attempted to be more directly useful. A study of them seems to show that those which have attempted to meet a particular need have been the most successful.

One of the lines in which it appears that we may be of considerable service is to present a short course for water commissioners, canal superintendents, and those charged with the distribution of water. These officers affect the interests of every one who uses water in the state. Upon their knowledge and skill depends, to a great extent, the agricultural production of the state. While, fortunately, there are a great many able and skilled men, in many cases the character of their knowledge is such that the division of water is not correct. As the writer has elsewhere pointed out, if one person receives too much, another receives less than he is entitled to. Thus an improvement will be immediately effective in the justness of the distribution. It should be the aim of such a course to be of immediate application.

The water commissioners who are charged with the distribution of water from the streams of the state to the ditches, and the canal superintendents or patrolmen charged with the distribution from the ditch to consumers, have clearly related needs.

I am led to the conviction that the most effective way to introduce more accurate methods will be by training the men who are to use them. Such a course should consist of the knowledge needed primarily by the commissioners and superintendents in their duties—measurement of water from streams into canals, with explanation of the methods and practice in use of current meters; a discussion of the varying conditions, what to expect and how to meet them; discussion of their rights and their legal position. In this connection it would be desirable to secure the services of several of the successful water commissioners and canal superintendents to give one or two lectures each, based on their ex-

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perience and leading to a conference. For the legal conditions, several lectures by some attorney who makes a specialty of irrigation law, also one by the state engineer, and doubtless others, as the plan worked out in detail, if the plan meets with your approval.

Such a course should take two or perhaps three weeks. A small fee might be charged. The time should be early enough to precede the irrigation season. Situated as we are the cost would be small, consisting essentially of the necessary printing and other expenses, and perhaps a small sum to those invited to lecture.

Some canal companies will doubtless be enough interested to urge their superintendents to attend, and perhaps may make inducements for them to go. If the state engineer and the governor use their influence, there will be enough, no doubt, to warrant its success. If as many as ten or twenty appear the first year, such a course would be justified, if we can make it of an extremely practical type.

POSTGRADUATE WORK.

There have been requests from time to time for postgraduate work in engineering, and several have applied at different times to take work of this character. Besides graduates of our own institution, we have had graduates of the University of Minnesota and of Harvard College for special work. Our situation is extremely favorable for development of work relating to the irrigation questions of the West. It is a question whether it is not desirable for us to give at least a year's work, outlined for our own graduates.

There has been no claim that the regular course should develop qualified civil engineers. The attempt has been to give the students taking that course as good a training as can be done in connection with their more literary work. If in addition to that a year's work, confined almost exclusively to the technical features of the work, could be given, our young men would be better qualified in the technical character of engineering, and such work might profitably well be undertaken.

During the past year the department has lost the services of Mr. Jay D. Stannard, who had been an assistant in the department since November, 1891. He left to enter upon work in the United States department of agriculture in their

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irrigation investigations. During his connection with the department he was recognized as an efficient and able instructor.

He has been succeeded by Mr. Jas. A. Stump, a graduate of the class of 1899, who has spent some time in special study at the University of Chicago. Mr. Stump gives more particular attention to the instruction in physics, both in the classroom and in the laboratory, and elsewhere as first assistant in the college work of the department. His work in the fall term has been highly commendable. Mr. Amos Jones aided in the instructional work in field and laboratory in the spring. He had had previous experience in field and railroad engineering. His excellent work warranted his continuation in more responsible work as assistant, and his continued good work has justified his choice.

Mr. R. E. Trimble, while employed on the experiment station, has helped occasionally in teaching, when experiment station duties may have required the time of the head of the department. Mr. W. R. Headden, stenographer to the station, has also occasionally assisted.

The department is, and has been, fortunate in the ability, devotion and earnestness of its assistants, and much of what it accomplishes is due to their efficient support.

In conclusion, I wish to acknowledge the constant support and appreciative encouragement of President Aylesworth, and to thank the board for their continued interest.

Respectfully submitted,

L. G. CARPENTER,
Professor of Engineering and Physics.

December 12, 1900.

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REPORT OF THE DEPARTMENT OF BOTANY AND HORTICULTURE.

TO THE STATE BOARD OF AGRICULTURE:

The department of botany and horticulture, I find, after three months' connection with the institution, to be for the most part well organized and fairly well equipped. The work will, then, be continued along the same lines as before, being changed only as improvements are suggested and the development of the department demands.

In order to help make the agricultural course more distinctive and the department more popular with the students, a few changes in the course of instruction may be suggested. As now arranged an undue proportion of the instruction is placed in the first term. In the term just closed instruction in freshman botany was given to seventy-two students in two divisions; horticulture to a class of twenty-four juniors; landscape gardening to a class of sixteen juniors. During the fore part of the term the entire freshman class was provided with labor, two hours per day, and during the latter part of the term the class in horticulture had laboratory work two hours per day. By transferring one of these classes to another term more time could be devoted to preparation, thus making better instruction possible.

More classes in both horticulture and botany should be provided. A course in plant diseases should be given as an elective for the agricultural seniors, and the course in plant histology should be open to women. A term's work in floriculture would also be valuable.

In this connection it may be mentioned that the method of teaching botany entirely from living specimens has been introduced and found to be eminently satisfactory. With living objects before them the curiosity of the student is aroused; consequently, the learning of names and plant relations becomes a pleasure.

It is proposed to continue the laboratory method of teaching throughout the course, using text books only as

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books of reference. Should the number of classes in the department be increased, another assistant will be needed, so that the professor and first assistant may be relieved of a part of the routine work, and further equipment in the way of microscopes and accessories will be necessary.

A few things that are most needed in the way of equipment may be mentioned. There were but few books in the department library at the beginning of the year. One small installment has been purchased, but many more are needed. Without standard works of reference and a knowledge of the latest achievements in science, satisfactory work can not be done. The stereopticon is rendered almost useless because of an unsatisfactory light, but with a small outlay of money it can be made very efficient. Some means of illustrating lectures is considered a necessity by many teachers. This is especially true in teaching the subject of landscape gardening. The camera is worn out and must be replaced before satisfactory work in photography can be done.

Too much credit can not be given to Prof. Crandall for the magnificent herbarium that he has succeeded in building up. It is unfortunate, however, that he was unable to complete the work and publish a flora of the state, as he had intended. Some means should be provided for completing the work, so that the institution may have something to show for the immense amount of labor that has been put upon it.

The greenhouses at present are used almost exclusively for the propagation of bedding plants, which are planted upon the lawns in summer. This method of lawn decoration is not only very expensive, but unsatisfactory. Flowering shrubs and borders of perennial flowering plants will serve the purpose much better, and when once placed in position they require comparatively little attention. The largest greenhouse may then be converted into a conservatory, which will not only be instructive, but attractive. Winter vegetables can be grown in the other houses, or they may be used in various ways that will be instructive to the students.

An effort has been made to have some of the successful fruit growers of the state give occasional practical talks to the class in horticulture. Such talks, given by men eminent in their profession, will be an inspiration to the students, and will give a zest to the study that is not easy for the instructor to impart. It is hoped to make these talks an important feature of the horticultural instruction.

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Since the work of the experiment station is so intimately connected with the college work, it will not be out of place to mention some of the lines of experimental work that have been suggested in the short time that I have been in the state. It will no doubt be best for the present to consider those problems only which are of immediate practical importance.

The state is so large and so varied in regard to altitude and climate that it may be divided, horticulturally, into a number of distinct regions. These regions have, to some extent, developed a horticulture peculiar to their limits. These regions of special crops and special varieties will undoubtedly become more and more distinct. Naturally, one of the first lines of work that come to mind is the study of the cultivated fruits of the state. Beginning with the apple as the most important, it is the intention to publish an illustrated bulletin, giving descriptions and general information on the varieties that have succeeded best in each region. This will be followed by a study of the other fruits and special crops, as time permits.

Aside from the ravages of pear blight, the fruit growers have thus far been annoyed but little with plant diseases; but as the era of fruit growing is being rapidly extended, it is to be expected that the combatting of plant diseases will soon come to be an important factor in horticultural operations. It is proposed to make the study of economic fungi an important part of the work of the department. Already there come to us strong complaints from pea growers in the vicinity of Longmont of an obscure disease of the pea. My assistant, Mr. Potter, has given this subject some attention, but he has arrived at no conclusion as to the cause of the malady. He believes that the future of the pea-canning industry at Longmont, involving some 2,500 acres, is threatened.

The attacks of pear blight make the growing of pears in many parts of Colorado impossible and renders the business of apple growing precarious. There is no known method of combatting the disease, but as there are varieties of both fruits that are less susceptible than others, it is reasonable to suppose that wholly resistant varieties may be produced. The production of new and meritorious varieties is a long and discouraging process, but in this instance the importance of the industry almost necessitates the taking up of this line of work.

Immediately associated with pear blight is the body blight of the apple and pear trees. In some localities the

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disease is known as "crater" blight, and is thought by many to be caused by the common pear blight. I have already done some work on this disease, and shall publish a preliminary report on the subject through the New York state experiment station. A practical line of treatment of the disease, as it occurs on pear trees in that state, will be recommended. The disease is worse on apple trees in Colorado than it is in New York. I have not as yet had an opportunity to examine any pear trees. There is no literature on this subject, though the disease is widely distributed.

Celery growers are troubled with the premature formation of seed stalks by the celery plants, and the formation of hollow or pithy stalks. Either condition renders the plants unsalable. Altitude and climate are thought to be responsible for these conditions, but it is proposed to determine if this be true. Should this be found to be the case, an effort will be made to originate a variety of celery that will be adapted to these conditions.

There are a number of other problems that have come to notice which are worthy of study, but I have indicated enough lines of work to show that there is much to be done. Other and perhaps more important subjects for investigation will constantly be suggested as I have opportunity to travel over the state and become better acquainted with the conditions.

Respectfully submitted,

WENDELL PADDOCK,
Professor of Botany and Horticulture.

December 10, 1900.

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REPORT OF THE DEPARTMENT OF ZOOLOGY, ENTOMOLOGY AND PHYSIOLOGY.

TO THE STATE BOARD OF AGRICULTURE:

I have the honor to submit herewith the annual report of the department of zoology, entomology and physiology for the year 1900.

WORK OF INSTRUCTION.

As a result of the increased number of students in the college the classes have been somewhat larger than in former years, and, although we have raised somewhat the standard for a passing grade, I have never had a smaller percentage of failure in my classes. This indicates a better average scholarship on the part of the students that come to us—an encouraging condition of affairs in the building up of an educational institution.

The work of instruction has been carried out in accordance with the schedule printed in the college catalogue. There has been one change in the text books used, Parker & Haswell's "Manual of Zoology" being adopted in place of Orton's "Zoology."

INSTITUTE WORK.

Several addresses have been delivered at meetings of horticulturists and beekeepers, and many letters of inquiry concerning injurious insects and the subject of beekeeping have been answered.

MUSEUM.

Good additions have been made to the insect collection during the year, and the systematic collection is in much better condition than ever before. The entire collection of Colorado coleoptera has passed through the hands of Prof. Wickham, of Iowa University, who is a recognized authority in

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that order. Mr. Ball has made large additions to the hemiptera and done much to put the group in order for reliable reference. Mr. Titus, in connection with his thesis work for the master's degree, has done a large amount of good work on the wild bees (family Apidae) and has added many species to the previous college collection. The writer has added many species of Aphidae (plant lice) to the collection, with many records upon their habits.

The additions to the museum outside of the insect collection have been small. They are as follows:

ADDITIONS TO MUSEUM, 1900.

Specimens	Purchase or Gift From	Locality	Number
Lynx	W. C. Stover (gift)	Running Water, Wyo.	1
Golden eagle	E. D. Ball (gift)	Fort Collins	1
Nest of woodpecker	Carlos Stannard (gift)	Fort Collins	1
Stone drill	H. J. Faulkner (gift)	Fort Collins	1
Fossil shell	R. S. G. Titus (gift)	Fort Collins	1
Aurelia sp	Marine biological laboratory	Woods Holl, Mass.	1
Jelly fish	Marine biological laboratory	Woods Holl, Mass.	2
Sea anemone	Marine biological laboratory	Woods Holl, Mass.	1
Plume hydroid	Marine biological laboratory	Woods Holl, Mass.	1
Egg-string, whelk	Marine biological laboratory	Woods Holl, Mass.	1
Quahog (shell)	Marine biological laboratory	Woods Holl, Mass.	12
Vermes	Marine biological laboratory	Woods Holl, Mass.	1
Jelly fish	C. P. Gillette (gift)	Woods Holl, Mass.	2
Squid	C. P. Gillette (gift)	Woods Holl, Mass.	1
Sparrow hawk	F. Nichols (gift)	Fort Collins	1
Filipino beans	C. P. Gillette (gift)	Philippine Islands	22
Flag, United States	Mrs. A. Washburn	First raised in Larimer county	.....
	LOANS		
Horns Rocky Mountain sheep	S. W. Buffum	.....	1 pair

C. P. GILLETTE,
Professor of Zoology and Entomology.

December 20, 1900.

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REPORT OF THE DEPARTMENT OF CHEMISTRY AND GEOLOGY.

TO THE STATE BOARD OF AGRICULTURE:

I have the honor to present a statement of the work of the college department of chemistry and geology, and of its present condition and needs.

The amount of work done by the classes in these studies has conformed strictly to the requirements laid down in our catalogue. The methods of teaching during the past year have been varied somewhat from those of previous years, in that I have endeavored to present the subjects by means of illustrated lectures in chemistry, and by the use of the cabinet specimens in geology. The results have, in my opinion, been much more satisfactory than those heretofore obtained; though still leaving much to be desired, especially from the standpoint of the teacher. One advantage that is most noticeable is the increase in interest shown on the part of the students, which is more than adequate compensation for the increased work which this method entails upon the instructor.

During this year I have been much impressed with the idea that the maintenance of the interest in the mixed system of instruction, i. e., text book and lectures, is more easily attained by placing the text book instruction in charge of a competent teacher, and presenting the illustrated lecture work myself. While this gives a variety in the form of instruction, the individuality of two persons is brought to bear upon the classes without breaking the continuity of the instruction in the least. I have endeavored, throughout the year, to make the illustrative lectures cover the ground which has been presented by means of the text. As a result of this, at the close of the last college term the class in chemistry, for the first time since my connection with the college, now seven years, passed a satisfactory examination without a failure. The successful carrying out of this system requires more time than the method heretofore followed, and also more material

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and apparatus, with which we are gradually supplying the department as our needs arise.

LABORATORY WORK.

We have made no changes in the work of the chemical laboratory during the last year, having found that the method already in use gave us satisfactory results, and giving us the opportunity to fully impress the objects which are included in the scope of the course as now laid out, which does not aim to give the students more work in this department than is necessary to supplement the work which is done in the classroom and by lectures. In short, the laboratory work is intended to be a repetition of the work done in the class and lecture rooms, in such manner and to such an extent only as is deemed necessary to make the facts already presented evident and real to the students.

These statements will suffice to make plain the fact that we do not, at the present time, attempt to carry the instruction in chemistry beyond that which is necessary to give to the students the general principles of chemistry which are imperatively demanded for the carrying out of a general course of instruction. It has been my opinion for two years past that the time is already ripe for us to make an endeavor to extend this course so as to include at least some advanced chemistry in the lecture room, and analytic chemistry in the laboratory. Such a change can not be made at the present time except at the expense of some other course, and, therefore, I would most respectfully ask the committee to consider whether there be means at the present time whereby we can obtain at least two terms of elementary work. These two terms should include what is now given in the laboratory, and the equivalent of one term in the lecture room. It is not my desire to take from any other department any time, particularly in the departments of English studies, whereby they would be rendered less efficient, but the character of our institution seems to me to justify us in carrying this practical science to a considerable extent further than it is now carried. The facilities of our department at the present time are quite adequate to the extension of the work in chemistry at least one year. It is evident that this time can not be given to the department of chemistry under our present curriculum, but it seems to me desirable.

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GEOLOGY.

In the department of geology we have proceeded with the work as laid down in the catalogue, and have accomplished it with such degree of thoroughness as is to be attained in the time allotted. The cabinet has been of great advantage to us in both facilitating the teaching and in increasing the interest of the students. We have at present two terms devoted to this study. In these two terms we have to teach the elements of physical geography, mineralogy and geology. It is a question whether we may not, under the present conditions, advantageously devote one term to physical geography, requiring all students to take the two terms, instead of requiring elementary geology in one term and advanced geology in the other. At this time I can not urge such a change, but am fully convinced that it would be greatly to the advantage of our students.

I would acknowledge the willing and faithful work of my assistants, both in teaching and in the experiment station work.

Thanking the president of the college and the executive committee for their kind and cordial support, this report is respectfully submitted.

WM. P. HEADDEN,
Professor of Chemistry.

December 12, 1900.

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REPORT OF THE DEPARTMENT OF MECHANICAL ENGINEERING.

To the State Board of Agriculture:

I have the honor to submit the report of the department of mechanical engineering.

Taking the classes in the order of their arrangement in the curriculum, I beg leave to report upon the instruction given as follows: The members of the sub-freshman class have received instruction in freehand drawing during the entire college year; they have been taught how to make freehand sketches of geometrical models and other objects; they have also been taught how to make sketches from copies of acknowledged merit made by artists of established reputations, and for this purpose a graded series of drawing books have been used. In the freehand work, the students who are to work in the shops later on have been taught how to make sketches of machines; these sketches to be subsequently worked up into working drawings to be used in the shops. The sub-freshman class have received instruction in the shops in bench work in wood, having been taught the common operations of the carpenter at the bench. To accomplish this, they have been required to complete a series of exercises, comprising the various joints used in wood work, in every case being guided by a set of working drawings made to scale.

The students of the freshman class have received classroom instruction in the principles underlying carpentry and joinery. This work has been done by means of a text book and lectures, the object being to aid the students in obtaining a knowledge of the correct application to their work in wood of the principles explained in the classroom. They have received instruction in the proper shaping of the cutting edges of various tools and the manner in which they act upon the material under various conditions. The shrinkage and warping of wood have been explained, and practical methods given for constructive work to allow for these con-

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ditions. The selection of joints for various uses has been explained. The students themselves have made a series of joints of various types, which are now used in the classroom in connection with the lectures. This class has had two terms of instrumental drawing from copies and from measurements, and has also been taught how to shape into working drawings the freehand sketches they made in the sub-freshman year. Considerable time has also been spent upon tracing these drawings and reproducing them by the blue-print process. In the afternoon shop work they have taken up bench work in wood, if they have not previously had it in the sub-freshman year; in every instance working from drawings, and some who have completed the regular course in bench work before the end of the term have been put upon extra work, which has afforded them an opportunity to put in practice what they have previously learned. This year, so far, the class has, in addition to its regular educational exercises in wood work, completed twelve tables for the drawing room, which have been put in service and proved satisfactory.

Some of the freshmen have been occupied in the blacksmith shop, and have been receiving instruction in forging a series of exercises educationally arranged, and they have acquired considerable skill at the forge. All the cutting tools used at the lathes and planers in the machine room have been made in the forge room.

The sophomore class has been instructed in instrumental drawing in orthographic projection and isometric projection, and has been required to work out a number of problems in those subjects. The class has received instruction in pattern making for one term. It has been taught how to make patterns correctly, so that they may be used to advantage in the foundry. Many patterns for appliances used about the college have been made by these students.

The junior class has pursued the study of steam boilers. The proper design of modern boilers has been studied; riveting, bracing, staying, etc., have received attention. The selection of boilers for various purposes has been discussed, and wherever possible all available boilers have been examined with a view to having the students become familiar with varieties of construction. The care and management of boilers has also been taught to the members of this class, and as opportunity has offered the students have been entrusted

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with the care of boilers, preferably the boilers in the mechanical engineering laboratory. The principles of mechanism have received attention by this class, and they have been taught the underlying principles upon which the working of machines depend, and the various mechanical movements have been explained and their practical application shown in various kinds of machinery. Workshop methods and appliances have been studied and the methods and equipment of modern shops and factories have been studied with care. This class has also received instruction in the foundry, and has been taught how to mould and cast both in iron and brass. It has received instruction in plain work in moulding and in core work. The care and management of the core oven has been taught, the students making their own cores and finishing and baking correctly. All the iron and brass castings used in the shops during the past year have been made in the college foundry. As an additional aid to the more intelligent performance of their work in the foundry, they have received classroom instruction in the subjects pertaining to that work, the care and management of cupolas, the best practice of modern foundries, the proper selection and mixing of different grades of iron; and, in brass founding, the proper selection of metals and the production of alloys.

The senior class has had two terms of drawing, part of that time being taken up with the study of machine design, the latter work having been carried on by means of a text book and also by frequent reference to machines of acknowledged good design. This work calls for much original research and mathematical calculation. Each student has been required to produce one or more original designs during the year. The fall term shop practice of this class completed its line of shop experience, and its entire shop time has been spent in the machine room, where it was taught how to manage the lathes, planers, milling machines, and other machines and appliances in that room. The members of the class have made a variety of small tools, two steam engines, and have partly completed a lathe, besides keeping in repair all the machinery in the department.

In all the work of the shops the students have been required to work from drawings as much as possible, as it has become necessary for the workmen of to-day to be able to read working drawings. The study of the steam engine has been

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another branch required of this class, and a very comprehensive treatise on the subject has been used as a text book and the study taken up in a thorough manner. The thermodynamics of the steam engine has been taken up, as well as the practical working of the engine. Various kinds of valves and governors have been discussed; the Zeuner diagrams have also been studied and applied. The transmission of power by modern methods has been taken up, and a study of some of the most common forms has been made.

The mechanical engineering laboratory, although as yet not fully equipped, has afforded this class a greater opportunity of becoming familiar with steam and hydraulic machinery than we have been able to offer the senior classes of previous years. A fine eighty horse-power steel boiler has afforded them an excellent opportunity for study, and the five horse-power boiler has also proved of great value to them. They have also been taught how to indicate the four steam engines of the department, the students themselves fitting the engines with indicator pipes and brakes. They have been taught how to get the indicated horse power, the brake horse power and the friction of the engines. The two steam pumps have also been fitted up with indicator pipes by the students, and they have made a series of experiments upon these pumps, determining their efficiency, etc. They have been taught how to use thermometers, barometers, and calorimeters, and in this advance work have taken special interest. They have acquired a good degree of familiarity with indicator diagrams, and in connection with that work have learned to use the planimeter with accuracy. Gauge testing has also formed part of their instruction.

Respectfully submitted,

J. W. LAWRENCE,
Professor of Mechanical Engineering.

December 11, 1900.

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REPORT OF THE DEPARTMENT OF DOMESTIC SCIENCE.

TO THE STATE BOARD OF AGRICULTURE:

Before giving the outline of the work in the department of domestic science for the past year, I will preface the same by a few paragraphs relating to the establishment of this department.

The establishment of the department of domestic science in the Colorado Agricultural College was the outgrowth of the conviction that the education of a young woman is no more complete without training in the domestic art and underlying sciences than is the education of a young man without training in the practical arts of life.

Knowledge is an excellent thing; but knowledge and the acquired skill to apply that knowledge are infinitely better. To know what to do is important; to know the same thing, and, in addition, to have skill in doing it, is reaching out and taking hold of the best.

Thus committed to the doctrine that true education should include, and in fact does include, culture of the moral and mental powers in connection with the practical training in the industrial arts, the State Board of Agriculture illustrated its theory in the founding of this department in June, 1894.

The following fall witnessed the opening of the old horticultural building under a new name, with the purpose of making this feature a great success.

The appreciation of this work is manifest in the fact that since its introduction the number of young ladies in the college has more than doubled. Since the majority of young ladies will be home makers, this subject is of paramount importance. Through this training, that which seemed drudgery is transformed into an attractive, elevating and very useful art.

The course includes five terms of lectures and classroom recitations, as follows:

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I. *Hygiene and Sanitation*—This subject is taken up at the beginning of the winter term of the sophomore year. The text book used is a collection of *"Public Health"* essays relating chiefly to the home and school, and are classified in this way:

1. Study of the home.
   (a) Selection of location.
   (b) The building of the home, from foundation to attic, including materials used, the plumbing, heating, lighting, ventilation, etc.
   (c) The surroundings: lawns, trees, and shrubbery; emphasizing sanitary and hygienic conditions.
   (d) Furnishing the home for the purposes of convenience, adornment, and the happiness of the inmates.
2. The use of disinfectants.
3. Individual prophylaxis against disease.
4. School hygiene.
5. Foods.
6. Preventable causes of disease.

II. *Emergencies, Conversation, Etc.* — During the spring term of the sophomore year the leading aim is to teach self-reliance, presence of mind, an interest in general subjects, and to train the student to express herself concisely, intelligently and entertainingly.

The scheme is varied for each day in the week. On Mondays the subjects always relate to the human organism. For instance, the skin is studied under the divisions of functions and care. Tuesdays are devoted to emergencies. To illustrate: One subject taken is the resuscitation of the apparently drowned. In all cases of accident a physician should be called, but the attendant may be of great use while the physician is coming. On Wednesday each young woman is required to prepare for the class an item of interest that belongs to the general subject of home science. Thursday or Friday is given to written work, an emergency always alternating with the former. The lesson for Friday morning is one of great importance. Some subject for discussion is announced one week in advance, with a member of the class as leader. For twenty minutes the one in charge presides; then

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the instructor takes the chair and recapitulates, adding and modifying wherever necessary.

Since the art of conversation has been very much neglected in recent years, the young ladies appreciate this opportunity of giving special attention to so valuable and cultivating a subject, particularly since it is absolutely indispensable in the well-ordered home.

III. *Chemistry of Cooking and Cleaning*—In the fall term of the junior year the subject considered is the chemistry of cooking and cleaning. The practice of cooking can not be carried on successfully without some knowledge of chemical science. The text book used is the work of Mrs. Ellen H. Richards. The work of this term tends to lift the veil of mystery from many kinds of house work, and to fill the mind of the student with a broader conception of her sphere as a home maker. Moreover, the actual performance of the labor is materially lessened when these subjects are properly understood.

IV. *Science of Nutrition*—During the winter term of the junior year the science of nutrition is studied with Atwater's *"Chemistry and Economy of Food."* Bulletin No. 21, of the office of experiment stations, Washington, D. C., is taken as the basis. Much supplementary reading is required, and the study of dietaries is made an important feature of this division.

V. *Home Nursing*—At the opening of the spring term, Weeks's text book on nursing is placed in the hands of the class, and as thorough investigation and study as are possible, without clinical practice, is carried forward. In all of these lines attention is given to the subject of micro-organisms, as the knowledge of them and their functions is variously related to the matters under consideration.

Sewing—The afternoon work in sewing consists of drafting patterns, cutting out garments, plain sewing, plain and fancy stitches, and embroidery. Everything is done systematically and methodically, and not for a moment is sight lost of the high educational value of this training. Special instruction is given in dressmaking. Notwithstanding the fact that no student is required to purchase material for sewing, it is invariably done, because, in so doing, she is entitled to the product of her labor.

The Kitchen—The work in the kitchen laboratory includes the study of foods, with practice in all kinds of cook-

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ing and laundering. How to serve food, the care of the table linen, the arrangement of dining tables for all occasions, and how to make all kinds of food serve their best purpose at the least cost, are among the subjects considered.

Housekeeping—Since the building in which domestic science is taught is furnished, as far as possible, as a home would be, actual work in housekeeping is carried on. Sweeping, washing of wood and glass, as well as dusting, form a part of each student's duties.

General Topics—A lecture is given on each Monday afternoon on some topic relating to the care of the house, clothing, or person; social duties; customs of good society, and anything that will aid in the development of a perfect womanhood.

There have been ninety-nine young ladies enrolled in the department during the past year. Each succeeding year marks an increased interest in the science and art of housekeeping.

Respectfully submitted,

THEODOSIA G. AMMONS,
Professor of Domestic Science.

December 12, 1900.

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REPORT OF THE DEPARTMENT OF MATHEMATICS.

TO THE STATE BOARD OF AGRICULTURE:

I submit herewith the annual report of the department of mathematics.

The work of this department consists of giving instruction in all branches of mathematics taught in the institution. The classes are large and numerous, and the work hard, but enjoyable. The forenoons are devoted to teaching in the classrooms, while in the afternoons my assistant and myself keep "open house" in our office to help the weak and erring and give special instruction to all who may come to us for help. During the past year the department has carried on the regular routine work mapped out for it in the catalogue.

Instruction has been given to students in twenty-two different classes, having an aggregate enrollment of 711 and all the scheduled work has been done.

The work done by the students has, on the whole, been good. Of course, some are lazy and indolent, but the greater majority work hard, with good results. I wish to call attention to the present senior class. This class has just completed the work required of it in this department. Their work throughout the course has been more than satisfactory, and, without doubt, this is the strongest class in mathematics that the institution has ever known.

The classes taught during the year have been as follows:

WINTER TERM—1900.

Juniors in analytical geometry	21
Sophomores in trigonometry	37
Sophomores in descriptive geometry	17
Freshmen in geometry (two sections)	69
Sub-freshmen in algebra (two sections)	72

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SPRING TERM—1900.

Juniors in differential calculus	18
Sophomores in advanced algebra	28
Sophomores in descriptive geometry	15
Freshmen in geometry (two sections)	69
Sub-freshmen in algebra (two sections)	72

FALL TERM—1900.

Seniors in integral calculus	17
Juniors in college algebra	18
Sophomores in algebra	50
Freshmen in geometry (three sections)	116
Sub-freshmen in elementary algebra (two sections)	92

The only thing in the course of mathematics as scheduled in the catalogue that I can criticise is the lack of time in some of the higher branches. We should have two terms for analytical geometry instead of one, and three terms for calculus instead of two. When our course here is extended, I hope the honorable members of the board will consider this suggestion, for it seems to be a much-needed change.

Respectfully submitted,

EDWARD B. HOUSE,
Professor of Mathematics.

December 12, 1900.

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REPORT OF THE DEPARTMENT OF RHETORIC AND PHILOSOPHY.

TO THE STATE BOARD OF AGRICULTURE:

I take pleasure in complying with the laws of the state regulating reports from heads of departments at the State Agricultural College, and so herewith transmit to your honorable body, through the president of the college, the annual report of the department of rhetoric and philosophy from December 1, 1899, to December 1, 1900.

During the winter term, 1899-1900, there were four regular classes conducted by the department, viz.: the senior-junior class in logic, the freshman class in rhetoric in two divisions, and the sub-freshman class in rhetoric. Of each of these I shall report in detail.

The class in logic consisted of twenty-five students—members of the seniors of the agricultural, civil engineering and ladies' courses, juniors of the mechanical engineering course, and such unclassified students as elected the course. The class met daily in Mr. Gillette's classroom, the regular classroom for rhetoric and philosophy being used at that time by other classes.

The course in logic was elementary, and was presented through recitations from Gregory's "Practical Logic" as a text book, discussion, and many original supplementary exercises prepared both by the class and by the instructor. The stress of the course was placed upon the minute working out of the syllogism as the basis of scientific reasoning. Another aim of the course was to bring out in a clear manner both the deductive and the inductive sides of inference, and to point out some of the principles of philosophy that are involved in them. The text book in use proving antiquated and entirely inadequate for the best interests of the class and for the truest realization of the aims of the course, Creighton's book, just out, was substituted for the use of later classes.

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The class in advanced rhetoric and rhetorical analysis was composed of eighty-two students of freshman rank, reciting daily in two divisions; one at 8:45, and the other at 9:30, in the morning. Genung's "Practical Rhetoric" and "Rhetorical Analysis" were the text books used as guides for this course, and the time and attention of the class was devoted mainly to the study of theme or essay structure and the fundamental principles of the different forms of discourse.

Sixty-one students, mostly of sub-freshman rank, were enrolled for the course in elementary rhetoric, commonly called "Lessons in English." The text book used was Lockwood's "Lessons in English," supplemented by Strang's "Exercises in English." This course was a continuation of the course begun in the fall term of the year, and its later work extended through the spring term of the year, the class then numbering fifty-four.

During the spring term the class in advanced rhetoric numbered sixty-seven—still in two divisions—and the sort of work followed was similar to that of the preceding term.

The class in psychology, scheduled for the members of the sophomore class, ladies' course, and such others as might choose the study, consisted of twenty-four students, who took a twelve weeks' course, using Halleck's "Psychology and Psychic Culture" as a guide. As so much of the after philosophical work of the student depends upon psychology, or, at least, upon a reasonable knowledge of the subject, it seems to me that all the branches of philosophy given in the college should be offered as electives, within reach of all students of all courses above sophomore rank.

Through the kindness of the president of the college and by the vote of the board, I was allowed to spend the vacation months in study at the University of Chicago. At that great school I gained many good and serviceable ideas along the lines of philosophy and rhetoric, not only from the requisite study and from the classroom instruction, but also from the meeting and contact with instructors from all parts of the United States and from all ranks of colleges and academies. Moreover, the opportunity for free and unlimited consultation on all the great and fundamental problems which confront the instructor in rhetoric and composition are, in themselves, worth all the time and money spent on such courses by those attending them.

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During the fall term of 1900, just closed, I have conducted classes in ethics, elementary rhetoric, civil government and Latin.

The class in ethics was composed of two young ladies. Owing to the present course of study, the subject of ethics is scheduled for the ladies' course only. As I said before, this branch of philosophy ought, by all means, to be a senior elective, as it is a prerequisite to all sociological enquiry and research.

At the beginning of the fall term the courses in rhetoric and English composition were put on a new and radically safe modern basis, and a recent text book was adopted for use in both the elementary work and the advanced course. The new book minimizes theory and catechetical methods by making the work intensely practical by *doing*. The students are required to do a great deal of writing, which is personally inspected and criticized by the instructor. Personal consultation is had with the students as much as possible, and their individual needs are recognized, the whole aim first, last and all the time being their clear and effective use of language in expressing thought.

The course in elementary rhetoric offered work this fall to one hundred and four students. The work has been done cheerfully, in spite of the fact that most students are prejudiced against rhetorical studies, coming to us from the various public schools of the state with but a meager preparation in composition. Rhetoric has been so sugar-coated, generally with a pretense at *quasi*-literature, that about the first effort that the new student of the Colorado Agricultural College has to put forth is to learn to spell, to read, and to express himself in pure English.

The class in civil government numbered seventy-two students. At the beginning of the fall term Fiske's "Civil Government in the United States" was substituted for the little manual previously in use, which at best was a mere syllabus of the subject. The new book is more scholarly, interesting and reliable—a vastly better book in every particular for both instructor and student.

All through my work, whether in rhetoric, philosophy, or Latin, I have had the earnest and kind co-operation of President Aylesworth, and I have yet to record my first disappointment in securing the necessities of time, equipment and general support from him or from the management of the college in general.

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For the kindly confidence reposed in me and in my work for the school by the members of the board and all others in authority, I am deeply grateful.

Respectfully submitted,

EDWARD M. TRABER,
Professor of Rhetoric and Philosophy.

December 12, 1900.

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REPORT OF THE DEPARTMENT OF HISTORY AND LITERATURE.

TO THE STATE BOARD OF AGRICULTURE:

Permit me to submit the following report of the department of history and literature for the past year.

The work of the winter and spring terms, 1899-1900, was completed as outlined in the course of study, by my predecessor, Prof. Jennie E. McLain. The records show large attendance upon all classes.

After my election at the spring meeting of your honorable board I spent the summer term at the University of Chicago, and entered upon my duties at the college last September, at the opening of the fall term. During the term, which closed November 30, my class work consisted of twenty-five recitations per week, as follows:

Freshman Class—History. The study of Greece and Rome; text book and class lectures, supplemented, when possible, by literary work. Enrollment, seventy-one. Recitations in two sections.

Sophomore Class—Literature. General outline study of English authors; text book and topical outlines used, with lectures and readings. Enrollment, forty-seven.

Senior Class—Literature. Critical study of several English masterpieces. Enrollment fifteen.

German—An elective course in the elements of the German language. Enrollment, twelve.

New entries at the beginning of the winter term make my total enrollment in freshman history ninety-six. The class recites in two divisions. A large sub-freshman class begins, this term, a course in American literature, which will be continued the rest of the year. The seniors of the ladies' course enter this term upon the study of the philosophy of history. The German class continues the work commenced last term.

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I find my new surroundings congenial and helpful, and, while I have little as yet to report, my work opens with most encouraging promise. I have but one request or suggestion to submit. I have been unable to use the library, which is the laboratory of my department, as much as is desirable, since the students are occupied with recitations or laboratory work in other departments during almost all of the library hours. I hope that some arrangement may be made by which the library may be accessible for the necessary laboratory work of the students in literature and history. The culture value of such work can not be over-estimated.

Respectfully submitted,

VIRGINIA H. CORBETT,
Professor of History and Literature.

December 11, 1900.

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REPORT OF THE MILITARY DEPARTMENT.

TO THE STATE BOARD OF AGRICULTURE:

I have the honor to submit the report of the military department for the past year.

Up to this date 230 cadets have received instruction in this department since the opening of the fall term; a considerable increase over any previous year.

The organization consists of an infantry battalion of three companies, each company having a captain, two lieutenants, five sergeants and five corporals. The staff, commissioned and non-commissioned, consists of an adjutant, sergeant-major, quartermaster sergeant, color sergeant, and drum major. The band consists of sixteen musicians. The signal corps and artillery squads will be organized during the winter term.

Because of the large number of new students at the beginning of the year, it was necessary to continue the "setting-up" drill and individual instruction somewhat longer than has been the custom. Seven weeks were devoted to this work, but the result was gratifying when company and battalion drills were begun. The exercises during the latter part of the fall and the beginning of the winter terms have included the school of the company and battalion in close order. During the remainder of the college year it is the plan to perfect the organization in the work already covered, and also to practice the exercises in extended order, formation of advanced and rear guards, and the performing of guard duty. The ceremonies consist of parades, guard-mounting, reviews, and inspection. Inspection is to be held at least once a month. During unfavorable weather will be held such exercises as can be conducted in the armory. A portion of the time will be devoted to recitations in infantry drill regulations, manual of guard duty, and other subjects relating to our work. This was the plan of work during last year, and was fairly satisfactory. Instruction in signaling was given to as many as possible during the winter and

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spring term. Signaling with flags is first taught, and, when fairly well understood, the heliograph is used. Considerable interest has been shown in this work.

A military encampment held at the close of the college year affords the best possible opportunity for practical instruction. Could arrangements be made for holding an encampment each year, good would, no doubt, come from it. Through the kindness of the college faculty we were allowed the last six days of the spring term, 1900, for the purpose of going into camp. Adjutant General J. C. Overmyer, C. N. G., very kindly gave us the use of the necessary camp equipment. We were also indebted to many people of Fort Collins, who made liberal donations to aid in reducing the necessary expense. A six-day encampment was held at a net expense to the cadets of one dollar each. Besides becoming familiar with the other duties of soldiers in camp, those in the battalion obtained a very good idea of practical guard duty. Target practice was one of the features of our work. The ranges used were 100 and 200 yards. This work proved both interesting and helpful. A complete record of scores made was kept and averages up well. The practice in skirmishing in open fields, with the use of blank cartridges, added life and interest to the exercises.

It may not be out of place to refer to a new feature of our organization, and that is the band. It so happened that among our students there were musicians enough, having their own instruments, to make up a band of sixteen pieces. These men were transferred from the companies to which they belonged to the band, and were given the drill period for practice. The progress they have made entitles them to a great deal of credit.

The ordnance and ordnance stores of this department are in a good state of preservation.

Respectfully submitted,

R. A. MAXFIELD,
Professor of Military Science and Tactics.

December 11, 1900.

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REPORT OF THE COMMERCIAL DEPARTMENT.

TO THE STATE BOARD OF AGRICULTURE:

I have the honor to submit the fifth annual report of the department.

The following summary shows the subjects taught, the enrollment and withdrawals for the fall term of 1900:

Branches.	Enrollment.	Withdrawals.
Commercial arithmetic	57	7
Commercial geography	19	1
Bookkeeping	56	6
Stenography	31	3
Typewriting	39	4
Spelling	50	4
Penmanship	53	5

NEEDS OF THE DEPARTMENT.

The immediate needs of the department are stationery supplies for the offices in business practice, a small book case for the principal's office, and a platform for the teacher in the general classroom. The approximate total cost is fifty dollars ($50).

You will note from the increased enrollment that the department is in a flourishing condition. This is largely due, as in the other departments of the college, to the efforts of the new administration, which has not only resulted in a marked increase in the student body, but has brought about that vastly more important function, perfect harmony amongst the faculty and assistants.

While the popularity of the commercial department, as it is to-day, can not be questioned, yet, after more deliberate thought and study, I am still of the opinion that we are not doing as much for the youth of the land as lies within our power. The wealth of every nation is dependent upon its commerce. Therefore, everything that tends to better the

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commercial conditions of a nation adds wealth and prosperity to that nation. It has been conclusively demonstrated that to gain supremacy in the commercial world, it is necessary to give young men a thorough technical training. Educate them to cope successfully with the great problems which are daily confronting the "business man." Teach them business in the broadest sense. The vast resources of the United States and the recent acquisition of foreign territory furnish wide fields for the broad-minded business man. In view of such facts, I must again suggest that a "College of Commerce," consisting of a term of four years, be established, and that an appropriate degree be conferred upon each student who completes the course. I should make Spanish and German an important part of the curriculum, bookkeeping and stenography an essential but secondary part, and, above all, I should insist on thorough training in English. Such a school could easily be established when the change in the present college course shall be adopted. I believe it would be necessary to employ but one more instructor—a Spanish teacher.

Should my suggestions receive favorable consideration, I should be pleased to aid, to the best of my ability, in selecting such studies as shall be deemed proper for such a school.

Respectfully submitted,

CHAS. J. GILKISON,
Principal.

December 11, 1900.

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REPORT OF THE DIRECTOR.

TO THE STATE BOARD OF AGRICULTURE:

Gentlemen—I have the honor to present the following brief report of the experiment station for the past year as a department of the agricultural college.

A more detailed report of the operations of the station is given in the report which an act of congress requires to be submitted to the governor.

The law provides that the experiment station shall be a department of the college with which it is connected. It has sometimes been thought that the attachment was merely for convenience. A more general view of the scope of the station would, however, make it appear that it is an important feature in the primary objects of the college. It is generally recognized that an important function of a university is in the increase of knowledge as well as its diffusion. In that respect the agricultural experiment station has charge of the increase of knowledge relating to agriculture. Its duties are those of investigation along lines which will be of value and of material interest; it also has certain duties of dissemination of the results of these investigations. While endowed by congress in the Hatch act, this does not necessarily replace the support of such objects on the part of the state or of the college. As a matter of fact, the experiment station has taken from the college, to a great extent, the work incumbent on it in the state law regarding the Agricultural College. Thus, while the United States law prevents the use of the Hatch fund for the support of the college, it is not improper for the funds of the college to be used for purposes of investigation, if it is thought proper by the board. The location of the station in connection with the college has thus been of mutual benefit, as it has enabled the station to use more or less of the equipment of the college, and has also enabled the college to carry on the investigations which otherwise it might not have been able to do.

The results of the investigations are distributed by means of bulletins, reports, lectures, correspondence, and

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personal conferences. The annual reports are required by law of congress. They are printed in limited editions, as they largely contain administrative and technical features not of general value, but which ought to be placed on record. It is desired to make these reports the depositories of such material and observations as should be placed on public record, and to make the bulletins prepared for distribution correspondingly briefer and more free from technical matter.

The bulletins are issued from time to time. At least four must be issued annually. The regular edition has been 7,000 copies; there are 6,000 names on our bulletin mailing list. The press bulletins form another series that has recently been started. The plan will probably deserve development. The object of these bulletins is to give opportunity for reports of progress and the distribution of information which needs to be sent out at once. As the number of agricultural journals in the state is small, it may be desirable to distribute these more generally than has been done. As it has been, such a bulletin as the one on sugar beet insects was sent to every sugar beet grower in the state whose address we had, and was distributed by the officers of the sugar beet companies. The one on "Russian Thistles as Forage" was distributed throughout eastern Colorado. The station has also published weekly a short report of the stage of water in the river, called "Poudre River Bulletins." This information is acquired by the station in pursuance of other investigations, and this form of publication was taken to make the information immediately available for those who could use it.

In distributing the bulletins it is very desirable to reach as many of the people of the state who can use them as possible. As the fund is supplied by the United States, it has not been thought proper to refuse requests from applicants wherever located. It is undoubtedly true that a large number of the bulletins are not used. It does not seem advisable, at present, to classify the list and send bulletins to those who seem most likely to need them. Experience shows that the greatest benefit from the bulletins is obtained in the most unexpected quarters. The profuseness with which nature distributes seed, in order that a few may grow, suggests that we have no reason to be discouraged if many of our publications do not find favorable lodgment.

A very important and sometimes burdensome means of sending information is through correspondence. Each member of the station staff receives many inquiries more or less

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germane to their line of work. Most of such inquiries come to the office of the director, and are referred to the other members of the staff for answer. Wherever possible, it has been the policy of the station to answer all inquiries, or to place the inquirer in the way of obtaining the information sought.

The farmers' institutes form a well-recognized means of reaching the local public. The demands have not been of such extent as to be particularly burdensome on the workers of the station. While, sometimes, the time and preparation required is regretted, attendance on these institutes have compensating advantages for placing the work in more direct contact with various communities, and in enabling the worker to learn of the extent of the questions which may need investigating.

Some of the eastern stations have taken up the work along the line known as nature study. Of these, the most prominent is Cornell, which has done work of value for several years. It is doubtful if the Hatch fund could be used for this purpose, but it would seem proper that the station should be the medium for this work if it be so desired. Cornell has freely aided in such work in many states outside of their own boundaries. As the work is carried on by state appropriation, it feels unable to carry on its work in Colorado, and has suggested that we take hold of the work here where it leaves off.

The past year has been the first of the station under the organization adopted last winter, on the lines recommended by the department of agriculture. The investigations carried on have been along fewer lines, and have tended toward finishing some of the numerous minor lines which have been carried on in previous years. The work of each member of the staff has been of high quality and extensive in amount. Five regular bulletins have been published, aggregating 216 pages; also four press bulletins and twenty-six river bulletins. The annual report consisted of 114 pages. The amount of printed matter distributed in these ways has been nearly one and one-half million pages.

The entomologist has carried on important investigations with the codling moth, and also important work on the grasshoppers of the state, as well as in the apiary. The chemist has issued the second part of the soil study on sugar beets, and has a large amount of important investigational work still to be published. It is gratifying to know that this sta-

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tion was one of the first to begin investigations with sugar beets and their adaptability to our conditions. Ten bulletins on this subject have been printed, the first being issued in 1889. The work of the station along this line has had much to do with convincing both the people and investors that the state was well adapted to this industry. The gratifying results of the recent factories in eastern Colorado have more than borne out the claims of the station, and have resulted in getting Colorado a profitable industry. The irrigation engineering section has continued its seepage measurements in the Arkansas valley, on the Rio Grande, the tributaries of the Platte, and the Uncompahgre. Some eight hundred miles of measurements of this character have been made, also additional measurements on the duty of water. This section has a large amount of material awaiting publication.

The resignation of the agriculturist, and the absence and resignation of the horticulturist, have made a break in the work of these sections, so that less has been done than would ordinarily be shown.

During the year the sub-stations at Rocky Ford and Cheyenne Wells have been in operation under the plans adopted in the spring. An important part of the work of the superintendents was to be outside of the grounds of the sub-stations in investigating the various problems of these localities. The sub-stations thus form a means through which the main station can reach out its hand to these localities and come in contact with the problems affecting them. In both cases the change in plans has been more than justified. The superintendent of the Plains sub-station visited a large part of eastern Colorado, and made important investigations. The superintendent of the Arkansas Valley sub-station also visited different parts of that valley, and carried on helpful work on the problems of sugar beets and the cantaloupe industries.

The department of agriculture has given notification that it will not sanction the expenditure of the Hatch fund at the Plains station after the present season on the former plan. The changed methods and the investigation of the problems of the plains, rather than the expenditure for farm operations, seem to meet their objection, and we may doubtless still continue such investigations.

The sub-station near Monte Vista was located on land belonging to the state, with title conditional to its use for

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experimental purposes. With the practical abandonment of this sub-station, the state land board has called for the return of the land to the state, and has leased the land to other parties. A committee was appointed by the board to dispose of the property at that place belonging to the station. A report of the result has not yet been rendered.

The land of the sub-station on the divide, near Monument, was also furnished conditionally, but the title became vested in the station after the expiration of ten years. The ten years expired in September. Efforts have been made to purchase, but the arrangements have not been completed at this date.

With the accumulation of records, the loss from possibility of fire becomes greater. Many of the records could not be replaced. The experience of other stations, as in West Virginia, Georgia, and California, which have lost all their accumulated files and records, shows that this is more than a possibility. A fire-proof vault in each of the sections having any accumulation of records is very desirable, especially so in the office of the director.

Respectfully submitted,

L. G. CARPENTER,
Director.

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REPORT OF VETERINARY SCIENCE DEPARTMENT.

THE STATE BOARD OF AGRICULTURE:

Gentlemen—The work in veterinary science has consisted essentially in class room lectures and clinics at the college barn, there being very little opportunity for original investigation.

When first assuming the duties of veterinarian at the college, the question of how to accomplish the most with the limited means at hand, and with the brief time that could be spared for this work (the curriculum being already full), furnished subject for some earnest contemplation.

There being no text books published at all applicable for such a brief course of instruction, it was decided to give lectures covering each branch of the work undertaken, and supplemented by practical instruction at the barn.

Early in the fall a free clinic was advertised, and the farmers and stockmen of Fort Collins and vicinity readily responded, resulting in a mutual benefit, a large number of most interesting cases being brought to the attention of the students, and the owners of live stock receiving my advice and prescriptions gratis.

The work taken up includes anatomy of domestic animals, diseases common to farm animals, lameness and principles of horseshoeing, contagious and epizootic diseases common to the West, and a short course of bacteriology.

Considering the comparatively insignificant pretensions of this branch of the college work and the slight expense entailed, I feel that all has been accomplished that could reasonably be expected.

Some misdirected efforts in the care of the live stock on the farm has been corrected under the new regime, and the testing and subsequent dissecting of the diseased cattle have furnished most wholesome instruction for the students, and will leave the herd clean and one of which the institution can justly be proud.

The work accomplished suggests more forcibly than ever the need of enlarging upon this branch of instruction.

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In judging of this work and its possibilities, we must not be confined to what veterinary medicine does for the live stock industry from a commercial sense in protecting the animal wealth, but must take cognizance of the broader sphere of usefulness in what the science does for the health and lives of the people themselves.

There is no subject extant that furnishes greater opportunities for scientific investigation for the immediate and lasting benefit to mankind.

Prophylaxy belongs essentially to comparative medicine, and the two branches, human and veterinary, are inseparable.

Micro-organisms, which are responsible for our many ills, must be studied in the lower animals as well as in man, if at all, and the bond of inseparable usefulness in the protection of the public health has been sealed by the discovery of the antitoxin principles of serum therapy. The immunizing of animals against fatal contagious diseases; the certain detection of latent diseases which can not be known by physical symptoms, and their early isolation, before they have spread their disease germs among their kind, or even to the human family; the cure of some diseases by the administration of repeated doses of attenuated virus, and the prevention of disease by their early administration, are phases of the role of veterinary science and give us a glimpse of its possibilities.

But for tuberculin we never should have even suspicioned the existence of tubercular consumption in the few Jerseys in the college herd, and the bacilla-laden milk would have continued to be used as human food. This thing is going on to an alarming extent all over the state and the whole country.

The dairies, especially in the suburbs of our large cities, are milking consumptive cows and peddling the milk, and in many cases without restraint, and yet the authorities attach severe penalties to the case of the man who adds a little ditch water to his milk to keep up the supply.

This thing is going on all over the country, notwithstanding the fact that it is now generally agreed by those informed that this is the greatest source of consumption in the human family. Mallein is used successfully in diagnosing glanders in the horse long before any symptoms are manifest; vaccine employed to protect mankind from smallpox; tetanus antitoxin in the treatment of lockjaw; diphtheria antitoxin for diphtheria, as well as antitoxins successfully employed in anthrax, rabies and many other diseases.

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The value of animal serums employed for diagnostic, prophylactic and therapeutic purposes, to mankind, can not be estimated.

On the other hand, there is a grievous loss to the farmer and stockman from losses incident to the common ailments and accidents of live stock, and which in the aggregate is enormous. I find the better class of farmers have, through the agencies of the Agricultural College, farmers' institutes, farm journals, etc., become generally possessed of considerable knowledge of the value of foodstuffs and fertilizers, and are studying these things, but are lamentably ignorant on the practical usages of veterinary science.

Circumstances have compelled me to limit my instruction almost exclusively to this latter branch of the work.

Very respectfully,

GEO. H. GLOVER.

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Report of the State Board of Agriculture.

PART II.

REPORT OF

THE AGRICULTURAL EXPERIMENT STATION.

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Report of the State Board of Agriculture.

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THE AGRICULTURAL EXPERIMENT STATION.

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THE STATE AGRICULTURAL COLLEGE
OF COLORADO.

THE THIRTEENTH
ANNUAL REPORT

OF

The Agricultural Experiment Station

FOR 1900.

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THE STATE AGRICULTURAL COLLEGE.

THE AGRICULTURAL EXPERIMENT STATION

Fort Collins, Colorado.

BOARD OF CONTROL:

THE STATE BOARD OF AGRICULTURE.

Executive Committee in Charge.

Hon. P. F. Sharp, Denver, Chairman.

Hon. J. L. Chatfield, Gypsum. Hon. B. F. Rockafellow, Canon City.

Hon. Jesse Harris, Fort Collins. Hon. P. A. Amiss, Pruden.

Station Staff.

L. G. Carpenter, M. S. ..... Director and Irrigation Engineer
C. S. Crandall, M. S.* ..... Horticulturist and Botanist
C. P. Gillette, M. S. ..... Entomologist
W. P. Headden, A. M., Ph. D. ..... Chemist
W. W. Cooke, B. S., A. M.† ..... Agriculturist
B. C. Buffum, M. S.‡ ..... Agriculturist
J. H. Cowen, B. S., M. A.§ ..... Horticulturist and Botanist
W. Paddock, M. S.‡ ..... Horticulturist and Botanist
R. E. Trimble, B. S. ..... Assistant Meteorologist and Irrigation Engineer
F. L. Watrous ..... Assistant Agriculturist
L. A. Test, B. M. E., A. C. ..... Assistant Chemist
E. D. Ball, M. S.‖ ..... Assistant Entomologist
C. H. Potter, M. S. ..... Assistant Horticulturist
F. C. Alford, B. S. ..... Assistant Chemist
Joseph Lownes, B. S.¶ ..... Assistant Chemist
E. S. G. Titus, B. S. ..... Acting Assistant Entomologist
H. H. Griffin, B. S. ..... Superintendent

Arkansas Valley Sub-station, Rocky Ford.

J. E. Payne, M. S. ..... Superintendent

Plains Sub-station, Cheyenne Wells.

Officers.

President Barton O. Aylesworth, A. M., LL. D.

L. G. Carpenter, M. S. ..... Director
A. M. Hawley ..... Secretary
L. M. Taylor** ..... Stenographer and Clerk
W. R. Headden, B. S. ..... Stenographer and Clerk

* Entered Government service July 1, 1900.
† Resigned September 1, 1900.
‡ After September 1st.
§ Elected July 2; died July 12, 1900.
‖ Absent on leave from Oct. 1.
¶ Died December 9, 1900.
** To May 1, 1900.

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LETTER OF TRANSMITTAL.

To His Excellency,

CHARLES S. THOMAS,

Governor of Colorado:

In accordance with the act of congress, which requires a full and detailed report of the operations of the experiment station to be made annually to the governor, I have the honor to present herewith the thirteenth annual report. The financial statement is for the United States fiscal year, ending June 30, the other operations being reported substantially for the calendar year.

Respectfully submitted,

L. G. CARPENTER,
Director.

The Agricultural Experiment Station,
State Agricultural College,
Fort Collins, Colorado,
December 22, 1900.

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SECRETARY'S FINANCIAL STATEMENT

OF THE

EXPERIMENT STATION FUNDS.

FOR THE FISCAL YEAR ENDING JUNE 30, 1900.

RECEIPTS.

	Hatch Fund.	Special Fund.	Total.
United States treasurer	$15,000 00	.....	.....
Balance on hand July 1, 1899	.....	$ 391 69	.....
Rent, farm and miscellaneous sales	.....	1,133 22	.....
Total	$15,000 00	$ 1,524 91	$16,524 91

DISBURSEMENTS.

Salaries	$10,394 06	$ 372 12	$10,766 18
Labor	2,320 18	116 30	2,436 48
Publications	644 90	381 10	1,026 00
Postage and stationery	194 00	16 28	210 28
Freight and express	33 14	1 65	34 79
Heat, light and water	2 08	3 30	5 38
Seeds, plants and sundry supplies	265 29	24 68	289 97
Fertilizers	55 05	.....	55 05
Feeding stuffs	14 00	60	14 60
Library	10 75	.....	10 75
Tools, implements and machinery	128 56	7 25	135 81
Furniture and fixtures	46 64	32 30	78 94
Scientific apparatus	81 03	2 50	83 53
Live stock	42 75	.....	42 75
Traveling expenses	652 13	97 10	749 23
Contingent expenses	54 00	.....	54 00
Buildings and repairs	61 44	152 26	213 70
	$15,000 00	$ 1,207 44	$16,207 44
Balance on hand July 1, 1900		317 47	317 47
Totals		$ 1,524 91	$16,524 91

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REPORT OF THE DIRECTOR.

The agricultural experiment station, in accordance with the law of congress, is made a department of the State Agricultural College. By its fundamental act the Agricultural College was required to do considerable experimental work, so that the passage of the Hatch act by congress did not inaugurate agricultural experimentation at the Agricultural College but endowed work for that particular purpose. In furnishing this annual income, the government made certain conditions, which were accepted by the state legislature by act of 1889.

The experiment station is the special organization for carrying on the work of experimentation and as distinct from that of teaching. Nearly every member of the staff of the experiment station is also on the staff of instruction, and where this is the case, the salary is borne jointly by the two funds. While sometimes the demands of the station work and those of instruction seem to conflict, there is no doubt that the association of the college and station has been of benefit to each; to the station because it has thus found an organization already in existence, with high ideals, with equipment of building and libraries, and much apparatus available for investigation; and to the college because it secures the inspiration which comes only from contact with scientific problems at first hand. The connection has enabled both to secure men which neither could alone. It has also enabled the college to meet one of the purposes of institutions of learning—the development as well as the dissemination of knowledge.

The station has it own executive head, termed the director. Since September, 1899, this has been separate from the presidency of the college, as the experience of other states has shown to be desirable. The director is the official head of the station, has charge of matters relating to it, the authorization of expenditures, preparation of plans in conference with the staff, and subject to the approval of the executive com-

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mittee. As the station as a whole is termed a department of the college, the branches of the station have been termed sections, directed by a specialist. The officers are the agriculturist, the horticulturist, the chemist, the entomologist and the irrigation engineer, with assistants. There are two substations—one in the Arkansas valley at Rocky Ford, one on the plains at Cheyenne Wells.

The regulations of the station, as established by the State Board of Agriculture, and substantially following the suggestions laid down by Director A. C. True, of the office of experiment stations of the Department of Agriculture, are given in full. As compared with the previous loose organization, they place added responsibility on the director, and give him correspondingly greater power.

REGULATIONS OF THE STATE BOARD OF AGRICULTURE GOVERNING THE EXPERIMENT STATIONS.

"*Resolved*, That the following communication from the Director of Experiment Stations of the United States be spread on the records and adopted, as expressing the future policy of the board regarding the work and organization of the experiment station:

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., August 19, 1899.

HON. P. F. SHARP,
President of the Board of Agriculture, Denver, Colo.:

Dear Sir—Referring to our recent conversation regarding the organization and work of the Colorado Experiment Station, it seems to me that the following points should especially engage the attention of the governing board in considering the reorganization of the station:

1. The station is, under the law, a department of the college, and as such should have an organization which will consolidate it and enable it to work as a unit. Experience shows that this can best be done by giving the station its own executive head (a director), and organizing a staff to work under his immediate direction.

2. The director should be made fully responsible for the planning and carrying out of the work of the station, for its expenditures and publications, and for the management of all business details, and he should be given ample authority for these purposes. The board should look to him for the initiative in all matters relating to the station, including the nomination of members of the staff, and should ordinarily confine

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itself to the appointment of the officers of the station and passing upon the plans for work and expenditures submitted by the director, through the president of the college, and auditing accounts. The director and other chief officers of the station should be chosen to serve during good behavior and efficiency, and the plans of work and expenditures should be submitted to the board annually.

3. The members of the staff should be individually responsible to the director as regards station work and should be held to the performance of work ordered by the director, which would often involve the co-operation of several members of the staff. As members of the station staff, the professors should be distinctly subordinate to the director. In this respect they should hold a different position as regards station work from that which they hold as instructors in the college. Thus, the professor of chemistry is the head of the department of chemistry of the college, as far as instruction goes, and as such is subordinate only to the president of the college, but as chemist of the station he should act under the orders of the director.

4. The station council should be simply an advisory body, holding meetings for consultation on station interests, but voting, if at all, merely to express opinions.

5. The general plan of expenditures should be drawn up annually by the director after consultation with members of the staff, and approved by the board. This should include estimates for salaries, expenses of the several departments, publications, etc. There should always be a certain reserve fund, to be spent at the discretion of the director, to meet emergencies arising during the year.

Expenditures should be made on requisition drawn by the different members of the staff and approved by the director, and all bills should be approved before payment by the director. The accounts and vouchers for each year should be finally audited and endorsed by a committee of the governing board.

6. The main work of the station should be along one or two lines, and all members of the staff should co-operate in this work as far as practicable. This need not exclude smaller pieces of work in a few other lines, and it is well for each department to have some work in which it alone is concerned. In Colorado it seems natural and desirable that the station should concentrate its work on irrigation problems, and it should be a leading authority on these problems.

Plans for the work should be carefully drawn up annually by the director, after consultation with members of the staff, and when approved by the board should be carried out carefully and vigorously. Careful attention should be given to the proper recording of work, and the station records should be preserved in fireproof safes or vaults.

7. *All* the work of the station, wherever conducted (whether at Fort Collins or in other localities in the state), should be under the immediate charge of the director, or such member of the staff as he may assign to have charge, and the director should be made responsible for the management of all work without regard to locality. Sub-stations are not con-

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templated by the Hatch act, and have generally proved very expensive and of little value, those in Colorado not being exceptions to the rule.

The station should work for the general interests of the agriculture of Colorado and should carry on its investigations wherever they can best be prosecuted, but should be free to move its field work from point to point as the requirements of the work may demand. It is not fair to the farmers of the state to maintain expensive sub-stations in two or three favored localities. The amount of field work to be done at Fort Collins should be determined by the nature of the investigations pursued by the station at any time and may be relatively small. If the station is organized to pursue a series of *special investigations* for the benefit of Colorado agriculture there will be little difficulty in deciding where the work can best be done. The location of the work in any given instance should, of course, be left to the director and other expert officers of the station.

I am not sure I have covered all the points you desired me to touch upon. I shall, of course, be glad to write you further at any time.

Very respectfully yours,

(Signed) A. C. TRUE.

Resolved, That in order to carry the foregoing recommendations into effect, the following regulations be adopted:

1. That the experiment station shall be a department of the college (as provided by law), with the director as the responsible head. The heads of the sections, with the president of the college and the secretary of the State Board of Agriculture, shall constitute the advisory council to meet with the director from time to time for mutual consultation and consideration of station interests.

2. Excepting for the year 1900, for which year the executive committee will act, in March, for the board, the director shall prepare and submit to the board, at its annual (December) meeting, after consultation with members of the staff, plans for the station work and estimates for the expenditures for the following year. After approval by the board, it shall be the duty of the director to see that such plans are duly carried out, and thereafter, such work wherever carried on shall be under his immediate charge, or such member of the staff as he may assign to it.

3. Expenditures from the funds under station control shall be on requisition signed by the director, and the bills approved by him before being audited by the executive committee and paid. In the absence of the director at or near the close of the month, some other member of the staff may be designated by him to act in his stead in this regard.

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4. Bulletins or other regular publications of the station shall be printed on the approval of the director and authorization of the executive committee. The printing of these shall be done, where possible, on contracts made by the director at the lowest figure obtainable on competitive bids for such work upon uniform specifications.

5. That the director of the station be authorized and instructed to lease such portions of the lands now held by the State Agricultural College for experimental purposes, as are not needed for scientific experimentation. Further, that such land shall be leased only on condition that the lessees thereof shall keep and report to the director a complete record of the sowing, irrigation, cultivation and yield of the crops grown on such lands.

6. Further, that the director be instructed to inaugurate and maintain throughout the station work a fundamental and comprehensive system of experimentation along the line of irrigation and irrigated agriculture without detriment or prejudice to investigations or experiments of the several sections on subjects directly concerning their departments of the station.

7. All rules and regulations relating to the powers of the director or operation of the station which conflict with the above resolutions, are repealed."

Adopted December, 1899.

WORK FOR 1900.

Under the plan of organization contemplated in the regulations, the plans of work for the current year were submitted to the executive committee and adopted by them in April. As the report presented at that time and the schedules show the policy of the station and the conditions under which the station acted, it is given in full, as it gave some discussion of the conditions.

"Before giving the schedules of work of the experiment station, it is desirable to call attention to the general situation of the station and the changes introduced by the recent legislation of the board.

There have been five specialists working separately and independently. The two substations may also be added. Each has been doing earnest work, but on his own line of

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investigation, almost without relation to any of the others. As every question has various sides, and, for a complete investigation, needs the work of several specialists, this policy has prevented the cumulative influence of work from various sections. In other words, there has not been one station, but seven stations. As I take the instructions of the board, following the recommendations of Doctor True, they tend to unite the work without destroying the individuality of the worker.

If station experience shows anything, it is that the lines of investigation, whether of the station or of the separate workers, should be few in number and should be carried along some principal line; and that each investigation should be carried to completion before seriously beginning another.

Colorado is so rich a scientific field that every worker has been tempted to attempt too many investigations. The result has been a spreading of the efforts to such an extent that the progress of one investigation is blocked by the demands of the other. We thus have a great many lines of investigation in which something has been done for a series of years. Hence, as a matter of business sense, without regard to the importance of the investigations themselves, it is desirable to carry these inquiries to completion, in order to obtain the benefit of the time and money already expended.

The field is so broad, and there are so many interests which want investigation, that (a) evidently we must omit or postpone many questions, or take them up incidentally; (b) among them to chose more especially those which are peculiar to the state, utilizing the results of other states where possible, or leave to the stations of other states the investigations which those stations can or will take up; (c) carry on fewer investigations, but carry them to completion; (d) in the case of the substations, to cause them to supplement the work of the main station, systematize their records, and make their work available to the main station.

Our peculiar questions, where we can best add to the general scientific and practical knowledge, and wherein we can get the least help from other sources, are along the lines growing from the methods of agriculture; i. e., by irrigation. Water is an element in plant growth as essential as nitrogen; hence, while Eastern stations are searching for manures containing nitrogen, we are led by just as great necessity to hunt for water. The search for nitrogen is

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largely a chemical question; that for water involves, to a greater or less extent, engineering questions. Some of the most important inquiries along these same lines lie in the domain of the chemist, the botanist, and the agriculturist. Incidentally, there are other questions which are peculiar to our state, or to the present conditions. Where the studies elsewhere can solve the questions here arising, it is better to leave those to other stations.

The plains, covering nearly one-third of the state, justify a more systematic investigation into their possibilities. This is likely to be a question long of solution, and we should not be disappointed if a great deal of practical value does not result. Still, the extensive area involved justifies a serious study. The necessity of maintaining a substation at Cheyenne Wells, and the expense involved, hampers rather than aids the main inquiry. A considerable part of the most valuable work can best be investigated in the laboratory, or by examination of the specialists here.

The questions of the Arkansas valley now are sugar beets, cantaloupes, and the fundamental one of irrigation. The San Luis valley has the question of cereals and forage plants, in addition to the questions growing out of the water supply.

The Western slope needs attention. As a general proposition, we ought to begin to consider the special questions affecting them, with the idea that, when free from the entanglements of Eastern Colorado, some of their special questions may be taken up with vigor. It is thought that some desirable work can be begun this season along the line of the codling moth.

The schedules show the commencement of a main work along the lines of irrigated agriculture, wherein several sections are uniting in work of a common bearing. These are:

1. Continuation of investigations by the engineering section on the physical questions of irrigation and water supply.

2. By the botanical section, the starting of a study of the relations of plants to water, including a vast number of questions necessary to understand the principles of agriculture.

3. The beginning of a more extensive investigation on the irrigation waters of the state by the chemical section.

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There is a lessening of the incidental questions in the schedule, and, while secondary questions must be taken up from time to time, these are baneful in their effects on the best work of the station.

The schedules submitted are as follows:

SECTION OF METEOROLOGY AND IRRIGATION ENGINEERING.

1. The irrigation questions of the state, especially the duty of water, the seepage determinations on various streams, and more specific investigations in the Arkansas and San Luis valleys, including chemical analyses.

2. Meteorology as before, with reduction of some of the data already secured.

SECTION OF BOTANY AND HORTICULTURE.

1. A study of the relations of plants to water.

2. The study of the flora of the state, special attention being given to:

1. The weeds of the farm and garden.
2. Grasses, native and introduced.

3. Economic fungi. The investigation of such depredations by fungi as may be reported to the station.

CHEMICAL SECTION.

1. A study of the irrigation waters of the state, including work on Part II of Bulletin No. 46, "A Soil Study."

2. Continuation and completion of a study of methods used in extracting beeswax from old combs.

3. Study of Colorado grasses in co-operation with the department of botany.

4. A digestion experiment with sheep. This is intended to be supplemental to Bulletin No. 39.

This work, already begun, will require more than a year for completion.

EXPERIMENTAL WORK OF THE AGRICULTURAL SECTION.

1. Wheat—Tests of the effect of changing from a higher to a lower altitude, and from a lower to a higher; the same for latitude, and for both combined.

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(a) Oats—Tests for the effects of changes in altitude, similar to those with wheat.

Tests for the development of a variety of oats with a thinner husk.

2. The value of alfalfa ensilage for feeding.

3. Land Plaster—The benefit to be derived from its use.

Secondary and Incidental.

4. Peas and Oats—An endeavor to learn why peas and oats do not thrive in the vicinity of Fort Collins.

5. Alfalfa—Co-operative tests with Turkestan alfalfa.

6. Sugar Beets—Tests for the production of seed.

7. Feeding Tests—Are now being conducted with dairy cows and sheep.

8. Creameries—Collection of statistics.

ENTOMOLOGICAL SECTION.

1. *Unfinished Work:*

(a) Experiments with the codling moth, to determine the number of broods in different parts of the state, the relative values of different remedies, and to determine some points in life-history.

(b) A study of the *orthoptera* (grasshoppers, etc.) of the state. The object is to determine quite fully the species that occur in Colorado; also their range, food-habits, destructiveness to cultivated plants, and remedies.

(c) Collecting and rearing insects to determine food-habits, life-histories, and the Colorado fauna.

(d) Experiments for the destruction of miscellaneous insect pests as opportunities occur.

(e) Experiments in the apiary:

2. Testing different makes and styles of comb foundation.

2. *New Work:*

(a) A study of the disease known as "Foul Brood" for the purpose of determining whether or not the germs and spores can be destroyed in honey, so as to make it safe to feed the latter back to the healthy colony of bees.

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(b) The beginning of a study of insects injurious to sugar beets in Colorado.

THE ARKANSAS VALLEY SUB-STATION.

1. The Cantaloupe—An extension of previous work in controlling the blight, in a number of different places.

2. Sugar Beets—A study of the beet in the various soils of the Arkansas valley, and under different conditions.

A systematic attempt to utilize the experience of the many growers to determine the essential treatment and the best method to produce high-grade beets.

3. Experiments with the codling moth on one or more orchards.

On the Station Grounds.

CANTALOUPES—

1. Breeding for improvement by selection and hand pollination.

2. Trials of spraying for control of insects and blight.

3. The effect of different amounts of irrigation.

SUGAR BEETS—

For seed bearing and production.

With notes on those grown by leasers.

TOMATOES—

Experiments for control of blight.

Manner of planting and pruning as affecting production.

Secondary and Incidental.

Some tests on potatoes, hairy vetch, grasses, and wheat, with records on orchards and fruits.

Also observations in meteorology.

THE PLAINS SUB-STATION.

1. To examine the plains of Eastern Colorado with wagon and study the methods of those securing a foothold; and by personal contact and inquiry establish the basis for

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more specific inquiry, especially to study the methods of those individuals or communities securing a foothold.

2. To continue the test of cultivation and of varieties at the station.

In this connection to use about twelve acres of station land for that purpose. The rest of the land to be continued in cultivation, substantially as at present.

A large part of the energies of the director during the past year has been given to the questions pertaining to that of office. The mailing list has been entirely revised, and transferred from the book form to a card index, arranged by postoffices and then alphabetically. It is also classified so the newspapers, libraries, exchanges and those desiring only special classes of bulletins, can be separated at once. The mailing list has materially grown, but until the rearrangement in method, it did not seem desirable to make a systematic effort to increase it. There are now about 6,500 people receiving the bulletins regularly. As the expense is borne by United States appropriation, it has not seemed proper to decline to send to any applicant in the United States. The files of bulletins from other states, a most valuable and necessary feature of the office, are nearly completed. To fill the vacancies has required much correspondence, and long search. As fast as the files of any state are complete, they are bound. The office has also been arranged for the more systematic preservation of the current files, and for conveniently mailing bulletins from the office.

During the year, five regular bulletins have been issued and mailed, and four are in press, to be issued early in the coming year. It appears that the list of issues for the coming year will be greater. There is more matter in condition for preparation for publication, needing only time on the part of the author to prepare. During the past year about a million and a half pages have been distributed.

The bulletins form one means of placing the results of the work of the station before the people interested. So far it has been the principal one. In addition, all the members of the staff take part in farmers' institutes in different parts of the state. These usually take place in the winter season. So far there has been little attempt at exercising so much control as would be involved in bringing the dates so as to

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least disturb the work of the station or the college. It would seem desirable that a closer supervision be had in order that they may become more useful.

The usefulness of the station is increased through the correspondence of the various workers. This is of considerable amount. Whenever inquiry is made, it is the policy of the station to give information asked for, or to place the inquirer on the way to a satisfactory reply. The inquiries often take much time, more, perhaps, than the questioner would willingly have required. At the same time all legitimate correspondence of this kind is welcomed. It is felt that this correspondence should be greater. It is desired that the farmers of the state should feel free to ask for information of the station, and should look to it for help in the problems which arise.

In order to reach many with information requiring immediate distribution, or of not sufficient completeness to warrant a bulletin, a series of shorter bulletins, called press bulletins, has been started. It is not intended that these shall exceed four pages, and preferably not so long as that. This series has not been developed with us as yet, but it promises to be one means of reaching many. These bulletins have been printed in smaller editions than the regular bulletins, and have been sent to newspapers, and to selected names according to the subject matter. As there are few papers devoted to agriculture in this state, it may be desirable to extend the circulation more widely and to increase the number.

For a number of years the irrigation engineer of the station has carried on measurements of the Cache a la Poudre river, and as the information obtained weekly was of considerable value to the local community, reports have been issued, termed river press bulletins. These have been distributed more especially in Northern Colorado, but have frequently been widely quoted elsewhere.

CHANGES IN THE STAFF.

Early in the spring the resignation of Prof. W. W. Cooke was presented to the board and accepted, to take effect September 1. Prof. Cooke became connected with the station, September 1, 1893, and for seven years has served as agriculturist of the station. During this time he has been

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the author of numerous bulletins issued by the station, and has been a very acceptable worker at farmers' institutes.

As his successor, Prof. B. C. Buffum, of the Wyoming University, was elected at the June meeting of the board. Prof. Buffum graduated from the Colorado Agricultural College in 1890, and became assistant to the irrigation engineer and meteorologist. He resigned the following spring to take a place at the University of Wyoming, where he has since remained. Prof. Buffum has been an ardent worker at that station, the results of his investigations appearing in numerous bulletins.

Prof. C. S. Crandall had been accorded leave of absence from May 1, to visit Europe for travel and study, and especially to visit the European herbaria to study the type specimens of plants of some of the Western species. He had been gone but a short time when his resignation was received, an advantageous offer from the United States Division of Forestry attracting him where his energies could be concentrated along fewer lines. He therefore resigned to enter the service, July 1. Prof. Crandall came to the Colorado Agricultural College as professor of botany and horticulture and horticulturist and botanist of the experiment station, on January 1, 1890, succeeding the late Professor Cassidy, and has been an indefatigable collector and student of Colorado botany. The station and college possess a large herbarium of Colorado plants.

At a special meeting of the board, on July 9, 1900, Mr. J. H. Cowen, M. S., M. A., was selected as his successor. Mr. Cowen had graduated from the Colorado Agricultural College in 1894, and on the death of Mr. Huffington was chosen assistant horticulturist. Mr. Cowen had been an enthusiastic student of natural science, and gave great help to the members of the staff along entomological and botanical lines, even before graduation. He was one of the collectors who is frequently mentioned in Bulletin 31 on Hemiptera, by Prof. Gillette. His name is one of the most common in the botanical collection. Resigning as assistant in 1898, he went to Cornell University, where he received the degree of M. A. in 1900, and was appointed to a fellowship in horticulture for 1900-01. He seemed remarkably well adapted for the work here, by taste and from preparation. His previous work here and his acquaintance with our conditions made him especially fitted for our work. Prof. Bailey says:

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"Mr. Cowen's death was a great shock to us. We thought him one of the best men whom we ever had. Of all the men whom I have recommended to position or who have been elected from this place, I think that none has seemed so well qualified to fill the particular place to which he was chosen as Mr. Cowen."

Within a few days after his election he was attacked with appendicitis. He went to the hospital at Ithaca, N. Y., for an operation, without a thought of fatal result. The operation seems to have been successful, but a complication from malignant jaundice caused his death within a few hours, and the station and college loses a worker in whom they had reason to place much hope.

At a special meeting of the board, August 15, Professor Wendell Paddock of the Agricultural Experiment Station of Geneva, N. Y., was chosen to fill the vacancy caused by the death of Prof. Cowen. Prof. Paddock graduated at the Michigan Agricultural College, and has been, for a number of years, assistant horticulturist at the Geneva station, where his work along the line of horticulture has resulted in numerous bulletins.

With the increase in the work of the director's office, Mr. L. M. Taylor, who had been acting as instructor in typewriting and stenography in the commercial department, as well as stenographer and clerk in the station, found the combined duties greater than one could attend to, and relinquished the work of the station. Mr. Taylor was found especially valuable from his knowledge of the work of the station, as well as for his exactness and skill. Mr. W. R. Headden, a graduate both of the regular college course and of the commercial course, was chosen to fill the place, and has been found an intelligent and able help.

With the first of January we lose Mr. Frank L. Watrous from the station staff. Mr. Watrous has been connected with the station almost ever since its organization. In the fall of 1888 he took charge of the Arkansas Valley substation, superintended the laying out of the grounds and refall of 1888 he took charge of the Arkansas Valley sub-staagriculturist in 1892. He has made an excellent record in both places, and takes with him to his new work the good wishes of those who have been associated with him.

While preparing this report the station loses the services of Mr. Joseph Lownes, assistant chemist, through death. Mr. Lownes, a graduate of the State University of

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Nebraska, and with former experience in chemical work in one of the sugar factories of that state, became connected with the station as assistant chemist two years since, and proved capable of every trust reposed in him. He clung to duty against the protests of his associates until his remaining strength was not sufficient to carry him through a siege of typhoid fever.

On account of poor health Mr. Carl H. Potter, assistant horticulturist, has asked for and been granted a leave of absence from active duty. He will, however, aid in the investigations at his home in the fruit regions of Western Colorado. He is succeeded in active work by Mr. F. M. Rolfs, a graduate of the Iowa Agricultural College, more recently an assistant at the New York Experiment Station, Geneva, N. Y.

Mr. A. H. Danielson, a graduate and assistant of the University of Wyoming, has been selected as assistant agriculturist, and on account of his skill in photography as photographer for the station, to aid all sections where photographic illustration is needed.

PUBLICATIONS.

The principal publications of the station are the bulletins. These have been issued during the year in editions of 7,000 copies, except in the case of bulletin 56, which was a technical bulletin, and issued in an edition of 2,000 copies. This class of publications is sent to the whole mailing list, except in the case of the technical bulletins.

The annual report to the governor was issued in an edition of 1,250 copies. This is sent to the other experiment stations, to the various agricultural colleges, to libraries which keep a file of the station publications, to newspapers in Colorado, and to exchanges, and some individuals on request.

Press bulletins form a recent series, designed as a means to distribute information to the press or to individuals, as the occasion demands. As Colorado has few papers of an agricultural nature, it will doubtless be necessary to give these wider distribution.

River press bulletins, a series issued as a private bulletin from the irrigation engineering section for several years, but not as a station publication until the summer of 1899.

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These include information obtained in certain studies of that section, which was desired by irrigation interests in Northern Colorado. Issued in small editions, and the distribution principally in Northern Colorado. Occasionally reprinted in other parts of the state.

The publications of the station since, and including, the last annual report have been as follows:

The twelfth annual report to the governor, 114 pp., 8 pl., 7 cuts.

Contents—

Report of the director, 12 pp.
Letter of Dr. True on Organization of Experiment Station Inventory, 3 pp.
Outline of work for 1899, 7 pp.
Report of agriculturist, 2 pp.
Report of horticulturist and botanist, 5 pp.
Report of entomologist, with notes on some of the injurious insects of the year, 4 pp.
Report of chemist, 1 p.
Report of meteorologist and irrigation engineer (with summary of seepage measurements on various streams, flow of the Poudre river, etc.), 10 pp.
Meteorological tables for 1898 and 1899, 17 pp.
Report of the Plains sub-station, 4 pp.
Report of the Arkansas Valley sub-station, with notes on crops raised, 16 pp.
*Record of the six years' work at the Plains sub-station, 16 pp.

Bulletins.

No. 53. Strawberries. 28 pp., by C. S. Crandall and C. H. Potter. Includes a summary of directions for treating strawberries, and a report on the new varieties which have been tested at the station.

No. 54. Apiary Experiments. 28 pp., 6 plates, by C. P. Gillette. Tests of the use of artificial foundation in comb building. Experiments to determine the extent to which it is used by the bees and the thickness giving the best results. Also notes on substitutes for pollen.

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*The record of six years' work at the Plains sub-station was also issued as a separate report.

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No. 55. Forests and Snow. (In press.) 20 plates, by L. G. Carpenter. Gives plates showing the condition of snow in thick timber and in this timber close by, with some discussion of the relation of forests to water supply.

No. 56. The Birds of Colorado (a second appendix to bulletin 37), Technical Series No. 5. 60 pp., by W. W. Cooke. Giving additional species of birds found in Colorado, based largely on the Carter collection and notes. This brings the total species seen in Colorado up to 387.

No. 57. Farm Notes. Alfalfa, Corn, Potatoes and Sugar Beets. 40 pp., W. W. Cooke. Gives notes on these subjects not previously published.

No. 58. A Soil Study. Part II. The Crop Grown: Sugar Beets, 46 pp., by W. P. Headden. A continuation of the study in bulletin 46, including studies of the effect of manure on beets; the drying out of beets, relation of richness of beets to their size; composition of beet ash; effect of soaking.

No. 59. Field Notes of Trips on the Plains, J. E. Payne. (In press.)

No. 60. Bush Fruits, C. H. Potter. (In press.)

No. 61. Bromus Inermis, F. L. Watrous, H. H. Griffin, J. E. Payne. (In press.)

Press Bulletins.

No. 1. Issued August, 1899, as a broadside. The Sugar Beet Caterpillar. By C. P. Gillette.

No. 2. Issued April, 1900. Colorado Sunshine. By L. G. Carpenter.

No. 3. Cantaloupe Blight. By H. H. Griffin. Giving some results of treatment with Bordeaux mixture. Sent to growers in the Arkansas Valley.

No. 4. The Beet Army Worm. By C. P. Gillette. Gives cautions and methods of treatment in case of appearance of this pest.

River Press Bulletins. The first one for 1900 was issued April 24, and continued weekly until October 16, making twenty-six regular issues.

WORK IN THE STATE.

With the great area and diversified conditions of Colorado, the station ought not, if it could, confine its efforts to

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a single locality. The variations in altitude and latitude represent as great difference in climate as between Charleston and Spitzbergen. While agriculture is not carried on through such range, the problems thus brought for solution are exceedingly diversified. And with the great areas and distances involved, the station must deliberately neglect many problems, of importance to some. In an area in the Eastern States no greater than Colorado, comprising the six New England States and New York, there are seven experiment stations, each of which receives as much from the government as the one in Colorado. Still they are not considered too numerous, for the states themselves support two more in the same area, and the state appropriations to the stations in this area are nearly $100,000 in addition to those from the general government.

The station does not attempt to confine its work to the region of the main station. More and more it is desired to take up and follow investigations to the localities where information is best obtained. Thus already the work of the station reaches out to many parts of the state, and it is hoped to become more effective as the present plans develop. During the past year the entomologist or his assistant has carried on systematic observations at Grand Junction on the codling moth; has visited both that section, the San Luis Valley, the Arkansas Valley, the Platte Valley, as called by the ravages of the sugar beet or other injurious insects. The chemist has analyzed many samples of sugar beets in connection with the investigations formerly reported, besides carrying on the laborious investigations already in progress. The change in the sections of agriculture and horticulture during the year has prevented the usual activity in those sections, nevertheless the agriculturist has carried on investigations in the San Luis Valley, looking toward inproving the wheat there available, with the special object of hastening the time of ripening to avoid frosts. The horticulturist has given attention to various plant diseases, and has been called away to attend to various plant diseases that seemed to be likely to prove serious. The irrigation engineer has carried on measurements on the Duty of Water at various places in the Arkansas Valley and in Northern Colorado. He has also measured on a large scale the seepage gains and losses from canals and to the streams, and begun measurements of the sediments in some streams of the state. These measurements have been extended to the Western slope. The superintend-

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ents of the sub-stations have been less confined to the limits of the station farms. The superintendent of the Plains Sub-station has visited the eastern portion of the Plains region of the state, as reported in bulletin 60. The superintendent of the Arkansas Valley sub-station has visited various parts of that valley in the study of the control of the cantaloupe blight, and of the sugar beet problem.

Investigations so carried on with the co-operation of other people have given, for investigations of the kind to which the method may be applied, far greater returns for the money available. It does not seem necessary to construct a canal to try an experiment in water.

It is gratifying that this work has been of use. The established recognition of Colorado as a state adapted to the growth of sugar beets and the establishment of the sugar industry on a sure foundation, has been possible through the work of the station through the past twelve years.

SUB-STATIONS.

Two sub-stations have been in operation during the past year.

The Plains sub-station:

A sub-station was started at Cheyenne Wells in Eastern Colorado in 1884. The expense of the first buildings and of the equipment was borne by the Internal Improvement Fund of the state, and by local subscription. The maintenance has been borne by the Hatch fund, appropriated by congress. During this time the plan followed was to attempt, on the land in the control of the station, to make a success of crops, either by new methods of cultivation, by conserving moisture, or in finding varieties which were best adapted to the conditions. For some years the superintendent in immediate charge has been Mr. J. E. Payne, a graduate of the Kansas Agricultural College, who has been an enthusiastic worker in attempting to develop the possibilities of the Plains. Still the trial cannot be considered a success, as a demonstration of profitable crop production. A charge in method seems desirable, and by studying the Plains on a broader plan more seemed possible of accomplishment. The area of what may be called the Plains of Colorado is so great, an extent of practically 275 by 175 miles, or say 40,000 square miles, an

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area greater than most states east of the Mississippi, that there is opportunity for much variation. Reports of successes of settlers who have maintained a foothold for a series of years, were worthy of investigation. Accordingly, both because more seemed possible to accomplish with the funds available, and also because the Washington authorities had ruled that the Hatch fund was not intended to maintain permanent sub-stations, a change in plan was desirable. The work planned at the sub-station was reduced, so as to free the superintendent from duties which required his presence there, he was furnished with a team and wagon, and his time largely spent in studying the conditions of Eastern Colorado, especially where settlers had maintained a foothold for a series of years. A portion of the report of the summer's trip will be issued shortly as a bulletin. The Plains have been given up generally as an insoluble problem, and they must necessarily be given up to the range industry. A basis for any sound study must be from facts as they are found, and the work as already developed, serves to show some hope of improvement. The area is so large, some 40,000 square miles, that some effort is justified. The nature of the problem is such that manifestly, a long time will be necessary, except as we study the experience of those already there.

The expense of the sub-station for the fiscal year has been $1,242.18.

The Arkansas Valley sub-station:

For reasons similar to those which led to a change in plan in the case of the Plains sub-station, the plan at the Arkansas Valley sub-station was altered. The trouble with the sub-stations, for one thing, has been, that not only has the station been attempting to do farming rather than experimenting, but the management of a farm of such size and variety of interests, has been sufficient to absorb the energy of the person in charge almost to the exclusion of work which is far more important. Accordingly, with the consent of the board, it was decided to lease all but a small part of the station farm, requiring, however, experimental observations from those to whom leased, restrict the area under the direct charge of the superintendent, free him from so much detail work, and expect him to devote a greater part of his time to investigation, and co-ordinate his work with that of the station as a whole, that the work would be mutually helpful. The results of the first year have fully justified the change,

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if any justification were needed. It is designed that the station shall thus be useful to the whole Arkansas Valley, not simply to the region about Rocky Ford. The expenditures on the station have been $1983.61 for the fiscal year and the receipts $1079.87. It is the first time in its history that the cost has been less than $2000, or the net cost less than $1000. The plan has not only reduced the expenses, but has increased the results, and this will be more evident with another year. The total cost of the station to date has been $31,466.07, with a return of $10,244.13.

The land at Monte Vista, at one time used as a sub-station, which was furnished temporarily by the State Land Board as long as used for experimental purposes, has been called for by the land board. It has been in their possession for over a year, though the formal transfer has not been made as yet. The station still possesses the improvements and some personal property at that station; the committee appointed by the board having found it difficult to dispose of the property to good advantage during the year.

The Divide station was organized on land furnished by subscriptions of small amount, and is of small area. As no support is likely to be given by the legislature, and as the buildings are fast going to ruin, the sooner the remains of the station are closed out the better it would seem to be.

The whole cost of the sub-stations has been during the thirteen years:

Arkansas Valley sub-station	$31,466.07
San Luis Valley sub-station	15,408.97
Plains sub-station	9,818.98
Divide sub-station	8,313.56

The returns, which reduce the net outlay, have been $12,505.74, principally from the Arkansas Valley sub-station.

Following the report of the director will be found the reports of the agriculturist, the horticulturist, the chemist, the entomologist, the irrigation engineer, and of the superintendents of the sub-stations. These give a valuable summary of this work, though the length of the reports is no indication of the work done. The agriculturist and the horticulturist entered upon their duties the first of September, after the field work of the year was substantially accomplished. The demands upon them in organizing the work, have been many. The reports of the sub-stations are relatively longer,

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as they include fuller statements needed for the use of the home station.

The present outlook for the station work is excellent, both because the field work is promising, and because, with the readjustment, the financial affairs of the station are being placed on a better basis, which will enable more to be accomplished.

Respectfully submitted,

L. G. CARPENTER, Director.

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INVENTORY.

NOVEMBER, 1900.

DIRECTOR'S OFFICE.

Office fixtures and equipment	$ 420 30	
Stationery supplies	197 60	
Half tones, zinc etchings and photographs	200 00	
Bulletin library	500 00	
		$ 1,317 90

AGRICULTURAL SECTION.

Implements and tools	$ 56 00	
Office equipment and miscellaneous	386 00	
		$ 442 00

ENTOMOLOGICAL SECTION.

Laboratory supplies	$ 73 95	
Entomological supplies	70 85	
Insecticides and insecticide apparatus	86 05	
Apiary	152 10	
In charge (miscroscope, etc.)	310 00	
		$ 692 95

HORTICULTURAL SECTION.

Glassware	$ 6 74	
Photographic apparatus and supplies	84 95	
Instruments	43 00	
Trees and nursery stock	294 10	
Herbarium	1,560 00	
Miscellaneous	1 25	
		$ 1,990 04

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METEOROLOGICAL AND IRRIGATION ENGINEERING SECTION.

Meteorological instruments	$ 545 15	
Office fixtures	34 00	
Stationery, books, maps, etc	32 60	
Irrigation and hydraulic apparatus	236 35	
Photographic supplies and negatives	146 95	
Miscellaneous	146 31	
		$ 1,141 36
Library		$ 1,100 00
Total main station		$ 6,684 25

ARKANSAS VALLEY SUB-STATION.

Water rights and apparatus	$ 1,836 00	
Fences, gates and bridges	338 30	
Buildings and improvements—		
Dwelling	$900 00	
Barn	750 00	
Wells, cistern and cellars	125 00	
Sheds and outbuildings	160 00	
Set farm scales	60 00	
Instrument shelter	15 00	
		$ 2,010 00
Live stock—four horses, three hogs		181 00
Implements and tools		393 15
Miscellaneous		54 50
Farm produce on hand—		
130 tons alfalfa	$390 00	
335 bushels oats	134 00	
125 bushels wheat	75 00	
226 bushels corn	79 10	
35 bushels rye	21 00	
20 bushels soy beans	24 00	
10 bushels cow peas	12 00	
75 pounds vetch seed	4 50	
4 tons sugar beets	16 00	
12 barrels apples	24 00	
20 tons sugar beets (rent)	100 00	

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Farm produce on hand—Continued.			
5 acres beet land (rent)	25 00		
110 pounds cantaloupe seed	55 00		
35 pounds beans	1 05		
4 pounds grass seed	60		
914 pounds tomatoes (estimated)	7 25		
Melon returns (renters)	60 00		
Returns from station melons (estimated)	20 00		
Miscellaneous	20 25		
		$ 1,068 75	
			$ 5,881 70

PLAINS SUB-STATION.

Dwelling and barn	$800 00		
840 rods barbed wire fence	100 00		
3,000 feet supply pipe (iron)	30 00		
		$ 930 00	
Two horses		75 00	
Implements		127 95	
Apparatus		152 10	
Supplies and farm products		73 50	
			$ 1,358 55

SUB-STATION AT MONTE VISTA.

Buildings, fencing, etc	$ 1,497 00		
One team horses		150 00	
Windmill and appliances		150 00	
Farm implements		82 15	
			$ 1,879 15

SUB-STATION AT DIVIDE.

40 acres land at Monument		200 00	
Buildings		729 00	
			$ 929 00
Total sub-station property			$10,048 40
Total main station property			6,684 25
Total experiment station property			$16,732 65

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In addition, the station has the use and control of other property, as long as used for experiment station purposes, as follows:

160 acres at Cheyenne Wells		$ 160 00	
Arkansas Valley Sub-Station—			
40 acres garden and fruit land	$3,000 00		
160 acres farm land	8,000 00		
		$11,000 00	
			$11,160 00

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EXCHANGES.

BOOKS, PAMPHLETS, SCIENTIFIC PROCEEDINGS, ETC.

ARGENTINE REPUBLIC:

Ministerio de Agricultura: Puerto Deseado.

AUSTRALIA:

Department of Agriculture, Perth.
Department of Agriculture, Victoria.

CANADA:

Department of Agriculture, Ontario.
Department of Agriculture, Ottawa.

COSTA RICA:

Musea Nacional: Ferraz. Informe de 1899-1900.

ENGLAND:

G. C. Bignell: The Ichneumonidae of the South of Devon.

FINLAND:

Acta Societatis pro Fauna et Flora Finnica, XIX.: 1.

FRANCE:

V. Vermorel: Defense des Recoltes par le tir du Canon; Note sur l'Emploi du Sulfure de Carbone.
L. Ravez: les Produits de la Vigne; les Systemes de Taille.
L. Ravez et A. Bonnet: Parasitisme du Phoma reniformis.

GERMANY:

Dr. C. Brick: Botanisches Museum Abtheilung fur Pflanzenschutz zu Hamburg. 2. 1899-1900.
Dr. M. Hollrung: Jahresbericht uber die Neuerungen und Liestungen auf dem Gebiete des Pflanzenschutzes.

HAWAII:

Henry S. Townsend: Report of the Minister of Public Instruction.
Report of the Hawaiian Experiment Station, Honolulu.
Bulletin of Manual Training School, Kamehameha.

INDIA:

Department of Land Records and Agriculture, Madras.

JAMAICA:

Institute of Jamaica, Kingston.

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NEW SOUTH WALES:

Department of Agriculture, Sydney.
Botanical Gardens, Sydney.

PERU:

Ministerio de Fomento: Moreno. Las Irrigaciones de la Costa.

UNITED STATES:

American Philosophical Society, Philadelphia, Pa.
Academy of Science, Rochester, N. Y.
Bussey Institution, Cambridge, Mass.
Carnegie Library, Pittsburg, Pa.
Department of Agriculture, Harrisburg, Pa.
Elisha Mitchell Scientific Society, Chapel Hill, N. C.
Geological and Natural History Survey of Minnesota.
Iowa Horticultural Society, Des Moines, Iowa.
Indiana Academy of Science, Indianapolis, Indiana.
John Crerar Library, Chicago, Illinois.
Kansas State Horticultural Society, Topeka, Kansas.
Lloyd Library and Museum, Cincinnati, Ohio.
Massachusetts Horticultural Society, Boston, Mass.
Missouri Botanical Gardens, St. Louis, Mo.
New York Botanical Garden, New York, N. Y.
New York State Museum, Albany, N. Y.
Portland Society of Natural History, Portland, Maine.
Public Library, Boston, Massachusetts.
State Board of Agriculture, Topeka, Kansas.
State Board of Agriculture, Boston, Massachusetts.
State Board of Agriculture, Raleigh, North Carolina.
State Board of Agriculture, Providence, Rhode Island.
State Board of Agriculture, Augusta, Maine.
State Board of Health, Augusta, Maine.
State Board of Health, Trenton, N. J.
State Board of Horticulture, Denver, Colorado.
State Board of Horticulture, Butte, Montana.
State Board of Horticulture, Sacramento, California.
Torrey Botanical Club, New York, N. Y.
Utah State Farmers' Institute, Ogden, Utah.
U. S. Weather Bureau:
    Nebraska Section.
    Illinois Section.
    Colorado Section.
    New Mexico Section.
    Minnesota Section.
    Tennessee Section.
    Wyoming Section.
    Oregon Section.
Wisconsin Dairymen's Association, Fort Atkinson, Wisconsin.

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SCIENTIFIC PERIODICALS.

Agricultural Journal and Mining Record, Maritzburg, South Africa.
Insect World, Gifu, Japan.
Kongl. Landtbrusk-Akademiens Handlingar och Tidskrift, Stockholm, Sweden.
Le Naturaliste Canadien, Chicoutimi, Quebec, Canada.
Sanitary Inspector, Augusta, Maine.

AGRICULTURAL JOURNALS.

Agricultural Epitomist, Spencer, Indiana.
Agricultural Gazette, Sydney, New South Wales.
American Agriculturist, New York, N. Y.
Acker und Gartenbau-Zeitung, Milwaukee, Wisconsin.
Beet Sugar Gazette, Chicago, Illinois.
Boletin de la Comision de Parasitologia Agricola, Condesa 4½, Mex.
Boletin da Agricultura, Sao Paulo, Brazil.
Co-Operative Farmer and Maritime Dairyman, Sussex, N. B.
Chicago Daily Drovers Journal, Chicago, Illinois.
El Agricultor Mexicano, C. Juarez, Mexico.
Elgin Dairy Report, Elgin, Illinois.
Edwards Fruit Grower and Farmer, Missoula, Montana.
Farmers Advocate, London, Ontario, Canada.
Farm and Dairy, Sydney, New South Wales.
Farm and Home, Springfield, Mass.
Farming World, Toronto, Canada.
Farmers Home, Dayton, Ohio.
Farmers Guide, Huntington, Indiana.
Farmers Tribune, Des Moines, Iowa.
Golden Egg, Saint Louis, Mo.
Home, Field and Forum, Oklahoma City, Oklahoma.
Homestead The, Des Moines, Iowa.
Indiana Farmer, Indianapolis, Indiana.
La Laiterie Belge, Renaix, Belgium.
Mark Lane Express and Agricultural Journal, London, England.
Milk News, Chicago, Illinois.
Michigan Sugar Beet, Bay City, Michigan.
Missouri Valley Farmer, Kansas City, Mo.
Mirror and Farmer, Manchester, N. H.
National Farmer and Stockgrower, Chicago, Ill.
National Stockman and Farmer, Pittsburg, Pa.
Orange Judd Farmer, New York, N. Y.
Ohio Farmer, Cleveland, Ohio.
Pacific Coast Fruit World, Los Angeles, California.
Practical Farmer, Philadelphia, Pa.
Practical Fruit Grower (The Southwest), Springfield, Mo.
Rural Topics, Morgan City, La.
Rural World, London, England.
Ranch and Range, Seattle, Washington.
Southern Planter, Richmond, Va.

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Sugar Beet, Philadelphia, Pa.
Up-to-Date Farming and Gardening, Indianapolis, Indiana.
Western Creamery, San Francisco, California.
Western Fruit Grower, Saint Joseph, Mo.
Wallace's Farmer and Dairyman, Des Moines, Iowa.
West Virginia Farm Review, Charleston, W. Va.

GENERAL NEWSPAPERS.

Chronicle-News, Trinidad, Colorado.
Colorado Springs Gazette, Colorado Springs, Colorado.
Denver Citizen, Denver, Colorado.
Denver Investor, Denver, Colorado.
Fort Lupton Advertiser, Fort Lupton, Colorado.
Golden Globe, Golden, Colorado.
Grand Valley Sun, Grand Junction, Colorado.
Montrose Press, Montrose, Colorado.
Public Ledger, Philadelphia, Pa.
Salt Lake Herald, Salt Lake City, Utah.
Sun The, Baltimore, Maryland.

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REPORT OF THE AGRICULTURIST.

The station worker who enters a new field labors under difficulty for a time. This is especially true of the agriculturist. He requires time to become acquainted with the conditions in the state and the needs of the farmer before inaugurating new lines of work which will result in information of value, and he must delve deeply into old records of what has been going on in the department before he is either able to continue the good work or report data which will be of intrinsic worth to the state's agriculture.

The conscientious station worker is anxious to be useful to those for whose benefit the station is established, and will not report anything but that which he believes to be reliable information, based on careful logical reasoning from observations and facts known to be scientifically accurate. Again, much data may be obtained which is of value, in that it adds to the sum total of human knowledge, but which is of no immediate practical value to the farmer. This kind of information should not be lost, but there are so many things which the farmer needs to know that I feel our first duty is to bring "grist to his mill." In order to do this, it is essential to know his conditions and needs. If we would aid him in solving the knotty problems with which he comes face to face, we must know what these problems are.

I have never been widely separated from the agriculture of this region, but only three months has passed since I assumed the duties of agriculturist in this station. On this account it is not possible for me to add to this report the results of experimental work done.

WORK OF THE DEPARTMENT.

My predecessor, Prof. W. W. Cooke, published two bulletins during the year. They were No. 56, a supplement to "Colorado Birds," and No. 57.

Farm Notes—The reader is referred to the bulletin on farm notes, published in July, which seems to contain a report of all the investigations of the station of which record

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was made up to July of the present year. The larger part of the time of the station assistant, Mr. F. Watrous, has been given to the management of the college farm. In addition to this, however, he has kept the notes on investigation with varieties of wheat and oats at the home station, and a complete and valuable set of notes on the live stock.

The past season was the first year of a well-planned experiment with varieties of wheat and oats. This work is being conducted on the home station, and on the farm of Mr. Jas. A. Kelly, at Monte Vista, in the San Luis valley. It not only contemplates the improvement of varieties for each of these localities, but also a study of these grains grown at high and low altitudes, and is designed to demonstrate the comparative value of improving seed at home or getting improved seed from a widely differing locality. The larger part of the time which I have been able to give the station work has been devoted to these grains. I made two trips to Monte Vista. On the first visit I assisted Prof. Cooke in harvesting the small plats of grain, and learned the method and purport of the experiment. At the second visit, in September, the grain in the straw from small plats was boxed, and that from larger plats was threshed out and shipped to Fort Collins, where studies are being made of the stooling, growth, and productiveness of each variety. The experiment promises results which will be of great value to the farmers of the state. Before leaving Wyoming, Prof. Farrer, of Australia, sent me a large number of new crosses of wheats. Prof. Foster, of the Wyoming station, has since kindly offered to divide these samples with me, and it is hoped that something peculiarly adapted to this climate and of superior milling quality may be obtained from them.

Since the beginning of the school year much of my time has been taken up with teaching, but some experimental work has been inaugurated. We have carried out an experiment in feeding Belgian hares. This work was merely inaugurated for class instruction. Each member of the junior class in stock feeding fed a separate ration to a lot of three hares for five weeks. The work was so carefully and conscientously done, and has apparently resulted so successfully, that it may be of sufficient interest to publish in bulletin form. Many people in the state have taken up the rabbit industry and are looking for information on the subject. Little information is available in regard to the feeding of hares. The flesh of the Belgian can not be excelled as food

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for man, and while these animals have the cleanest of habits, they will eat and thrive on a great variety of foods. The nine rations fed in our experiment had ratios of from less than 1 to 3 to nearly 1 to 9, and as all the rabbits did well, it indicates that they will adjust themselves to a wide range of foods and combinations of foods.

Investigations are now under way with the feeding of swine with rations, in which chopped alfalfa is a factor, to determine whether it is of advantage to give such roughage along with grain to fattening hogs. This experiment is being conducted by Mr. C. J. Griffith, assisted by Mr. W. B. Smith, one of the senior students in agriculture. An experiment has also been inaugurated to determine the comparative value of combinations of home-grown grain, compared with corn shipped in for fattening lambs.

FUTURE INVESTIGATIONS.

The plans of work for the ensuing year, an outline of which has been submitted to the director, contemplates the continuance of the work with wheat and oats at the home station and at Monte Vista, and the beginning of other work believed to be of greatest importance to the state.

I am anxious to investigate those subjects which are of immediate importance to the farmer and assist in the building up and improvement of our agriculture. From my observation and correspondence, I think questions relative to stock raising and the production and use of stock food, the securing and maintenance of permanent pastures, the growing of useful plants on waste lands, and practical problems in grain growing, potato raising and rotations to keep up soil fertility, are problems of paramount interest. It may be found wise to continue some work in a small way with sugar beets. The college has been growing beets for twelve years and published eight bulletins, giving results of carefully conducted experiments. This covers a wide field of investigation, and while the subject has not been exhausted, the industry is now on a commercial basis; factories already established are meeting with unexpected success, and it is not necessary that we should do more than investigate special things in beet growing which may demand our attention.

Some difficult problems confront the potato grower. Potatoes are one of our most important crops, and parts of the state have become famous for the production of this staple.

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For no apparent reason potatoes do not thrive in many parts of the state, and where they are most successfully grown there seems to be difficulty in keeping the seed from running out or deteriorating. We should investigate at home and cooperate in potato districts to assist in making the industry more remunerative.

NOTES AND RECORDS.

Taking trustworthy notes and keeping accurate and complete records is no small part of our station work. Unless the records contain complete and accurate notes of every investigation, systematically arranged and available, they are of absolutely no value. Heretofore it seems that the office help in this department has been too small to keep systematic records, and the notes taken are in widely scattered day books. Getting the back notes transferred to permanent record books, along with the recording of new work, will keep our office force very busy for some time. Until everything is so recorded that it can be referred to in the shortest possible time, we will make but slow progress. At present, when any question arises, which can only be answered by referring to back records, it may take a day or several days to find it.

In addition to the regular notes, I expect to make photographs an important part of the records. These pictures not only record many things which it is impossible to note, but they serve a useful purpose in illustrating when the results of our investigations are published.

ORGANIZATION.

The present plan for newly organizing the work in this department may be briefly stated as follows:

First—To lay out permanent experimental plats on the farm for general crop and soil investigations, and the continuance with trials under way of wheat and other crops. To establish a permanent pasture of different grasses and grass mixtures.

Second—To differentiate the work by putting the station assistant in charge of crops and crop and soil notes, and the college assistant in charge of the dairying and animal husbandry. Making each responsible for a part of the office work and records, and relieving each, so far as possible, from the details of farm labor.

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Third—The notes and records will be given first attention until they are thoroughly organized and systematized.

EQUIPMENT AND NEEDS.

Our actual equipment belonging to the station is very small, but it would seem that the relation of the college to the station enables us to use the farm and general farm equipment for many investigations. Properly recording the farm operations is continually giving results of scientific interest. At the same time we may organize a few lines of pure investigation. While we need many things in the department, the present greatest need of the station is more complete equipment for the work with wheat. We should have a small mill for making flour of small samples of wheat, and instruments for testing the flour from these samples. Such a mill, with power to run it, and the glutometers and other equipment necessary, would be expensive, but we will not be able to do complete and satisfactory work until they are obtained. The milling qualities of the wheat are as important as great productiveness. As yet, we know little of the comparative merits of the hundreds of varieties of wheat, compared with what there yet remains to be found out; questions than which few, if any, are of greater import.

In conclusion, I may say that the outlook for this department is bright. We are in a position to offer a helping hand to the agriculturists of the state. The station, in connection with the teaching in the college, offers great opportunity for young men who wish to receive training in scientific investigation.

B. C. BUFFUM,
Agriculturist.

Colorado Experiment Station,
December 12, 1900.

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REPORT OF THE HORTICULTURIST AND BOTANIST.

The absence of Prof. Crandall in the early part of the season, and his subsequent resignation to accept a more remunerative position, has left the work of the section practically at a standstill. Mr. Potter's time being largely taken up with the care of the department, he has been able to do but little research work. However, he has devoted considerable time to a disease of peas, which is especially severe in the vicinity of Longmont. This disease is of an obscure nature, attacking the plants below ground, and unless some means of combatting it is found, it is feared that the pea-canning industry at that place must soon be abandoned. This would mean a great loss to the farming community, since about 2,500 acres of land are devoted to pea growing.

Mr. Potter has also kept careful records of the work that was under way, and has prepared a bulletin on "Bush Fruits," besides attending to the station correspondence.

The variety tests of native plums has been continued, which includes not only a comparison of the different varieties in a commercial way, but a record of the blooming period of the varieties, and a study of the degree of self-sterility of the blossoms of the different sorts. These records are available for publication when sufficient additional data has been secured.

The variety tests with small fruits have been continued. The plantations include nineteen varieties of currants, seventeen of blackberries, eight of gooseberries, twenty-four of raspberries, and one hundred and fifty of strawberries.

The work on the flora of the state has necessarily been at a standstill for the season.

Respectfully submitted,

WENDELL PADDOCK.

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REPORT OF THE ENTOMOLOGIST.

I have the honor to submit herewith the annual report of the entomological section of the agricultural experiment station for the year 1900.

IMPORTANT INSECTS OF THE YEAR.

The Codling Moth (*Carpocapsa pomonella* Linn.) continues to be the most destructive insect to the apple within the state. Spraying with one of the arsenical mixtures has become quite a general practice in most of the apple-growing districts, and those who are spraying every year, most intelligently and thoroughly, are well repaid in the greatly improved condition of their fruit. It is to be regretted that so many spray carelessly and with too little attention to the right time, and that others can not be induced to take any measures for the destruction of this insect, thus making their orchards so many breeding places for the moth, which then spreads into other orchards.

The Peach Twig-Borer (*Anarsia lineatella* Zell.) continues in injurious numbers on the west slope, particularly about Grand Junction and Delta. At the latter place, on the 26th of last May, the writer found both larvæ and pupæ in considerable numbers under bands that had been placed upon the trees the previous season. I feel certain that bands upon the trees can be used quite successfully to reduce the numbers of this pest.

The Fruit Tree Leaf-Roller (*Cacoecia argyrospila* Walk.) has practically ceased to be a pest in the northern portion of the state, where it was so destructive for a number of years. Its disappearance seems to be due to a more general spraying of orchards and the increase of its natural enemies. Of the latter, insect parasites and red-winged blackbirds have been particularly efficient.

The Box Elder Leaf-Roller (*Cacoecia semiferana* Walk.) has also nearly disappeared as far south as Boulder, and probably for the same causes mentioned in case of the preceding species. Early and thorough applications of one

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of the arsenical mixtures to the foliage of the infested trees is an effectual remedy for the destruction of the rollers.

The Leaf-Crumpler (*Phycis indiginella* Zell.) has been reported, on several occasions, to the experiment station. The specimens have been sent from nursery stock and from young fruit trees, upon the twigs of which the little clusters of dried and crumpled leaves had attracted attention. Close attention to gathering and crushing or burning these leaf clusters during the winter will doubtless be sufficient to keep this insect from becoming seriously abundant.

Climbing Cutworms have been reported on different occasions as destructive to the foliage of small fruit trees. The past spring these cutworms were abundant in orchards in the vicinity of Fort Collins. They were first noticed early in the spring, before the trees had begun to put out leaves. They were taken, for the most part, under burlap bands that had been placed about the trunks for another purpose. From these caterpillars, *Agrestis auxilaris* was bred. The moths of this species are very abundant here upon the windows of our dwelling houses about the last of May each year.

The Eight-Spotted Forester (*Alypia octomaculata* Fabr.) is an ever-present pest in the vineyards of the state and upon the Virginia creepers. While it is most often complained of upon the latter vine, it also becomes quite destructive to grape foliage at times. Under date of July 9 last, Mr. W. A. Goodman, of Altman, Colo., wrote concerning this insect as follows: "What is it? and what can I do for it? It has almost devastated some vineyards in this vicinity."

We have found a spray of Paris green, London purple or arsenite of lime very effectual in destroying the caterpillars.

The Achemon Sphinx (*Philampelus achemon* Dru.) is also a common insect upon the foliage of the grape and Virginia creeper, and I have frequently found it more injurious than the preceding species. It is controlled by the same remedies.

The Pear and Cherry-Tree Slug (*Eriocampa cerasi* Peck) is generally distributed through the orchards of the state, and in some localities, where the proper remedies have not been applied, it has done great harm. I have found its injuries particularly severe about Grand Junction, in orchards that are poorly cared for. On the 25th of last May I found the eggs very abundant in pear leaves in some orchards

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near Grand Junction. As many as twenty eggs were found in a single leaf, and on the date mentioned only a single young slug was found. So hatching had just begun.

The Woolly Aphis (*Schizoneura lanigera* Hausm.) seems to be under very good control in most of the orchards of the state, and less inquiries are received concerning it than in former years. Many orchardists have begun using tobacco about the crown of the trees for the destruction of the root form, which is probably the best known remedy.

The Apple-Tree Aphis (*Aphis mali* Fabr.) has been increasingly abundant upon the foliage of the apple for a few years past. The eggs are deposited in great numbers upon the twigs of apple trees in the fall, but the lice do not become sufficiently abundant to attract attention before the middle of the summer, so that it is very seldom that anything is done to destroy them. Winter applications for the destruction of the eggs is what is needed for the control of this Aphis.

The Putnam Scale (*Asphidiotus ancylus* Put.) seems to be more destructive in Colorado than in the eastern states. While I have known but a few instances where it has been abundant enough to kill a tree, a few such cases have occurred and on several occasions it has been mistaken for San Jose scale because of its abundance. On the 26th of last May I visited an orchard near Delta, where the scale had been reported to me as very numerous. While the scales were found generally distributed throughout a large orchard, they were not causing serious damage to more than three or four trees, and it was doubtful if any of those would have died this year from its attack, though it was advised they be cut and burned. At the date of my visit I found the female scales just beginning to deposit their eggs, which were light amber in color. The scales were worst on a plum tree of some European variety.

Judging from the lately reported experiments of Prof. J. B. Smith, of Rutgers College, N. J., it is probable that all trees infested with this scale can be saved by careful treatment with a heavy crude petroleum during the winter. Prof. Smith found that an oil, testing not less than 42 degrees on the Beaume oil scale, would destroy scale lice and not injure trees, unless applied in unnecessary amounts.

The Willow and Cottonwood Scale (*Chionaspis orthollobis* Comst.) is a rather abundant scale on both willow and

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cottonwood in Colorado, and often attracts attention because of its white color. According to the observations of the writer, this scale is rather partial to the Carolina poplar, young trees of which are often badly incrusted with the scales. The frequent inquiry is "Will this scale get upon our fruit trees?" There is no danger of that. The twice-stabbed ladybird is a most efficient destroyer of this scale in the vicinity of Fort Collins.

Leaf-Hoppers (*Typhlocyba* Sp.) continue to be quite destructive to the foliage of grape vines and Virginia creepers in Colorado, particularly on the eastern slope of the mountains. The hoppers spend the winter in the adult state under leaves and in grass and in similar locations for protection. In the spring they attack almost any green thing until the leaves of the vines are open. I have found them at this time feeding freely upon leaves of strawberry, currant, gooseberry, alfalfa, grass and some of the native plants. When the leaves of the grape vine and Virginia creeper are open, they migrate to them, and continue feeding, and also deposit their eggs, one in a place, within the tissue of the leaves. They are frequently abundant enough to cause the death of most of the first leaves. It is the second brood that swarms among the foliage late in the summer and that attracts most attention. Methods of control have been given in bulletins from the station.

The Apple Twig-Borer (*Amphicerus bicaudatus* Say) is frequently complained of as a pest on the eastern slope of the Rockies within the state, but I have not known of its work in the western portion of the state. It seems to flourish best in the Arkansas valley, in the vicinity of Rocky Ford and Lamar. I extract the following from a letter by Mr. Frank Applegate, of Lamar, dated January 11, 1900: "I have found a bug of some kind in my orchard that has nearly ruined it. Can you tell me what it is? * * * It has bored many of the apple trees and grape vines. Many of the main limbs are bored, as well as the small ones." This is seldom a serious pest, and it is probable that cutting out the beetles and destroying them each winter will keep the borers from becoming bad pests, even in limited localities.

The Cottonwood Leaf Beetle (*Lina scripta,*) has attracted some attention the past year as a defoliator of Carolina poplars in nursery rows. It also attacks the foliage of larger trees, but its injuries to them have not been serious.

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The Wheat Aphis (*Nectarophora granaria* Kirby) appeared in destructive numbers in wheat fields in the eastern portion of the state the past summer. Mr. E. D. Ball investigated the injuries along the line of the Santa Fe railroad during the first week in July, and found the injury severe; so that he estimated that many fields would not yield more than half a crop as the result of the attack of the lice. Oat and barley crops were also attacked to some extent. Rather severe injuries to the grain crops extended as far west as Denver.

Cutworms in Alfalfa—A rather remarkable outbreak of cutworms in alfalfa fields occurred in the state the past summer. A few moths bred from worms sent for identification proved to be *Carneades tessellata.* A large percentage of the worms sent were parasitized, so it is hopeful that they may not be as abundant another summer. One worm, filled with small Encyrtid parasites, was isolated and the parasites counted by Mr. Titus, after hatching. The number from the one worm was 1,096.

Mr. Frank Beach, county surveyor of Bent county, wrote from Las Animas on June 3, as follows: "Dear Sir—We are troubled with millions of worms on the alfalfa. The young alfalfa coming after the hay seems a favorite food for them, and they keep it eaten off to the ground. They also like cabbage, sweet potatoes, rhubarb, lettuce, turnips, etc." On the 18th he wrote: "* * * There are no blossoms in my alfalfa fields; the worms have eaten the blossoms as fast as they appeared. The lower leaves have also been destroyed. Fields cut two weeks ago show no new growth. * * * Irrigation does not seem to affect them. I have tried Paris green and flour, 1 to 20, and it has proven effectual where they were on sugar beets. They are not as numerous now as they were two weeks ago." On June 20 he writes again: "The alfalfa worms are fast disappearing. The alfalfa hay in places stinks from the dead worms in it."

Mr. Beach also reported larvæ of ground beetles destroying the cut-worms in considerable numbers.

On May 16, Mr. M. B. Colt, secretary and local manager of the Alamosa Land and Canal Company, wrote, sending a number of the worms and telling of their injuries to alfalfa. On the 19th of May he sent more worms, and, among other things, said: "The worms sent you were gathered in a space about three feet square. Where they have attacked the al-

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falfa they have very nearly destroyed it. They are in patches in the fields from 40 to 100 feet square; other portions of the same field do not seem to be affected and the alfalfa is growing all right. This is the first injury we have had from these worms."

Mr. A. F. Middaugh, of the A. F. Middaugh Mercantile Company, Del Norte, wrote: "Dear Sir—I send you by mail a sample of alfalfa that has been cut off by the worms. * * * They work on the old plants more than on the new. Some fields they clean up in one year. For the last three years they have taken from one-fourth to one-third of my crop. When water is turned on they come to the surface and in places are so thick as to dam the water."

It was from the worms sent by Mr. Middaugh that the parasite mentioned above were reared.

On June 19 Mr. C. J. Lewis, of the Fort Morgan *Times*, wrote to make inquiry concerning "multitudes of worms that were eating the bloom from alfalfa."

Similar complaints came from Mr. Thomas Ashton and Mr. B. D. Prentiss, of Laird, Colo. Frank Payne, of the Cheyenne Wells experiment station, complained that the same worms were eating off melon plants.

The Beet Army-Worm (*Laphygma flavimaculata* Harv.) which was so destructive to sugar beets near Grand Junction in 1899, for some reason, did not appear in injurious numbers in that locality the past summer. The writer visited Grand Junction the last week in May of this year, and made a thorough search for this insect, without finding more than scattering specimens. During August, when the second brood should have been abundant, Mr. E. D. Ball visited the same locality and found only an occasional worm upon the beets.

The very sudden appearance of this insect, which had never before been considered injurious, in such destructive numbers, and its equally sudden disappearance, is quite remarkable. Particularly is this so from the fact that the fall brood of worms in 1899 were but little parasitized and the moths matured in enormous numbers. The latter must have failed, for some reason, to winter over.

Beets were planted extensively for the first time at Rocky Ford and Lamar last spring. The year previous the worms were noticed in considerable numbers in some experimental patches of beets by Mr. H. H. Griffin, who sent speci-

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mens to the station. This year the first brood appeared in destructive numbers, and Mr. Ball went to investigate the trouble, and gathered the following points of information concerning it:

The worms began hatching the first week in June, and by the 14th were abundant, and spraying was begun.

Moths were said to be flying abundantly about the beets two weeks before the worms were noticed.

The worms were worst on earliest planted beets. Late planted beets were only injured when near weeds or patches of early beets.

Beets were planted from April 10 to the last of May.

Those who used flour and Paris green found it cost about eighty cents per acre for material.

The poisons were quite effectual, particularly where two sprayings were made with Paris green.

Thousands of the worms were seen migrating, and they were found to be traveling from two to three feet a minute, by the watch.

The worms were found feeding upon native plants and weeds, especially of the beet family. Among these were lamb's quarter (*Chenipodium,* Sp.); Russian thistle, and *Atriplex.*

Other Beet Insects—I also extract the following from Mr. Ball's notes of the past summer on beet insects:

Nysius augustatus (often called "false chinch bug"), more or less abundant everywhere, in some cases causing beets to wilt and die.

Agallia uhleri (a small leaf-hopper), abundant nearly everywhere in the Arkansas valley, doing most of its work at the bases of the leaves.

Platymetopius, Sp., fairly common, but not doing serious harm.

Systena taeniata (a small flea-beetle), in small numbers nearly everywhere, east of Pueblo, in some places, quite abundant.

Monoxia puncticollis, quite abundant in some patches about Rocky Ford.

Deilephila lineata was found as an occasional feeder, especially where purslane was allowed to grow.

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Bee Paralysis—The disease which has taken this name in Colorado, and which has been so fatal in limited localities some years, was reported to the station by only one party this year. The report came from Mr. M. A. Gill, of Erie, and was dated May 16.

Black Brood, so far as I am able to determine, does not occur in Colorado. Numerous samples of diseased brood have been received with the question, "Is it black brood?" but in every case the brood has lacked the characteristics of that disease. All the cases examined seemed to be "pickled brood" insead. This latter disease is quite generally distributed over the state, but seldom, if ever, is serious enough to destroy or even greatly weaken a colony.

EXPERIMENTAL WORK.

The experiments of the year have conformed quite closely to the schedule that was presented for the year. Under "Collecting and Rearing Insects to Determine Food Habits and Life Histories" I would say that many species, not hitherto in the collection, have been added, and much has been added to the knowledge of food habits and life histories of the *Jassidae* (leaf-hoppers) through the efforts of Mr. Ball.

The experiments with the codling moth were very successfully carried out at the station, and several parties in other portions of the state have, at my request, made observations and experiments, which have greatly aided me in deciding upon the number of broods in different portions of the state. In this connection I would specially mention the names of Mr. H. H. Griffin, superintendent of the sub-station at Rocky Ford; Mr. Silmon Smith and Mrs. F. R. Smith, of Grand Junction; Dr. R. J. Peare and Mr. Thurston White, of Canon City, and Hon. David Brothers, of Edgewater.

The results of these experiments and observations are reserved for a bulletin, to appear later.

The study of the grasshoppers of the state has progressed fairly well, and will furnish material for a bulletin at some future time.

No new appliances were purchased for the apiary this year, and so no tests of appliances were made. The test of foundations was carried out. Bulletin No. 47, reporting tests of different foundations, was published early in the summer.

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The study of foul brood was not completed, owing to a lack of material for cultures at the time when it was needed.

The study of beet sugar insects was begun, and some of the notes on these insects are given above.

All of which is very respectfully submitted.

C. P. GILLETTE.

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REPORT OF THE IRRIGATION ENGINEER.

The investigations of the past year have been a continuation of the plans carried on for a number of years past. Besides the many minor questions, the principal effort has been given to essentially two investigations—one on the use of water for irrigation, as applied on different farms and under different conditions, and the other on the seepage or return waters. A report of investigations on the amount of water used was given in Bulletin 22, which has been out of print for a long time. The measurements since made give an additional mass of information, which is being worked up for early publication. The results show the importance of long-continued measurements on the same field, under the varying conditions of successive years, and that conclusions drawn from one or two years' observations may be shown to be very misleading by the longer series. These measurements have included crops at and near Fort Collins, two farms having been continuously used for nine years, at Holly, Rocky Ford, Canon City and Pueblo, besides records of canals on a larger scale. The importance of such data is that a knowledge of the amount of water so needed forms the basis of any reasonable distribution of water on canals, and serves to give a basis for estimate of the possibilities of our water supply.

The measurements of seepage return to streams, which was originally undertaken tentatively, have proven of much importance. Attention was at first directed along this line because the results were large for a moderate expense. Some measurements have been carried on over all the tributaries of the Platte; on the Arkansas, from the mountains to the state line of Kansas; on the Rio Grande, from the canon above Del Norte to the New Mexico line; on its tributary, the Conejos; and on the Uncompahgre, on the western slope. The linear distance is something like eight hundred miles, possibly more. Boulder and South Boulder creeks, Clear creek, Bear creek on the Platte, Conejos and the Uncompahgre were taken for the first time this year. The cost of these particular measurements has been small. The results of this series

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of investigations have been to demonstrate the fact that there is return to the streams of a portion of the water taken out for irrigation, and that this gives a constant increase of the area possible to irrigate. The measurement has been more recently directed to determine the important relation between the area irrigated or the amount of water applied, and the amount returning. The extension to the whole Platte valley makes a completeness to the series enabling us to study the amount in the valley as a whole.

Likewise, the study of the losses from canals has been continued. A larger fund of information has been collected. This likewise is leading to more important conclusions than were anticipated, and promises some of the most important deductions yet made. It is tending to show the source of the great losses in ditch distributions, and will lead to important applications in the way of economizing much of this loss, which is now so great.

The investigations on seepage were extended to the Rio Grande some years ago, in anticipation of the questions which it was foreseen might arise on that river to threaten the interests of Colorado irrigators. Such troubles arose as a side issue in the Elephant Butte case, which was on trial at the time of the last annual meeting of the board. Our investigations caused the writer to be consulted by both sides of the case, and his attendance for the defense. The case was one brought by the general government to restrain in the construction of a dam known as the Elephant Butte. An injunction was demanded because it was claimed that the impounding of the waters by the dam would materially affect the navigation of the Rio Grande some 1,700 miles below. The doctrine laid down by the United States supreme court had ominous bearings on the agriculture of the West, because in effect it said that irrigation had no rights which navigation was bound to respect. It was, however, successfully shown that the large part of the river arises in Mexican tributaries, and, in fact, that the river above the Conchos is frequently dry. It was also shown that the river loses so much of its water in the dry or little irrigated regions in southern New Mexico that the contribution of the river above El Paso to the lower stream was not material. The measurements which had been carried on at two stations in southern New Mexico for some years showed a loss of over one-half the flow in a distance of less than two hundred miles. As showing the menace to the western agriculture, it should be said that

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the entire navigation, on whose behalf the suit was urged, not at the complaint of the vessel either, consisted of one flat boat, drawing from one and one-half to two feet of water, and making, in the most favorable seasons, from two to three trips per month for a distance of less than two hundred miles.

The examination of the Arkansas conditions has been made with the view that similar questions are likely to arise on that stream.

A continuation of the study of the water flow in a typical irrigation stream has been made. An automatic register has been used and continuous records maintained.

Some arrangements had been made with the department of agriculture for co-operative work. As it was found that co-operation, as interpreted by one of the officers, involved the breaking of a long series of records of investigations originated and carried on by this station, this did not seem advisable unless a modification were made in that regulation.

Some of the duties falling on the head of the section as director of the station, and especially those caused by the rearrangement of the station work, confined the head of the section during the season more than was anticipated. As more of these duties are brought into routine form, the less interruption will be felt from them.

I wish to acknowledge the aid of Mr. R. E. Trimble, who for a long time has been assistant in this section, and upon whom the routine observations have specially fallen; of Mr. Amos Jones, assistant in the department of engineering, for aid in the measurements in the San Luis valley and for other irregular work; of Mr. R. W. Hawley, who acted in the Arkansas valley throughout the summer, traveling in so doing over 1,000 miles on his wheel, and to Mr. Antoine Jacob, a student in the senior class of the Agricultural College, for aid in measurements on the Conejos.

Among the many others who have been of material assistance may be mentioned Hon. B. F. Rockafellow, P. H. Sheridan, F. S. Earle, S. H. Atwater, and A. E. Gravestock, Canon City; C. K. McHarg, Supt. Bentley, and J. S. Greene, Pueblo; Samuel Taylor, Avondale; S. W. Cressey and J. H. Crowley, Rocky Ford; J. H. McClelland, Fort Collins; P. J. Preston and C. W. Beach, Las Animas; W. F. Crowley, W. M. Wiley and T. W. Montgomery, Holly; and M. V. Keator, Artman. Also the following water commissioners: L. H.

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Dickson, Longmont; Thos. Kneale, Niwot; W. E. Cole, Golden; Chas. Clark, Morrison; P. H. Shue, Ouray; W. E. Obert, Delta; C. C. Hawley, Fort Collins; J. B. Traxler, Lamar; L. C. Mitchell, Monte Vista; and J. C. Dalton, Manassa.

Many others gave freely of time and information, or even more.

A summary of some of the results is appended.

Respectfully submitted,

L. G. CARPENTER.

SEEPAGE GAINS AND LOSSES.

The measurements to determine the gains or losses from seepage have been continued as in previous years, and a summary is given in the following tables. It is expected to give these reports more in detail and to bring together the measusements made since Bulletin 33, on "Seepage or Return Waters from Irrigation," was issued in 1896. The measurements this year have been extended to several streams in the Platte basin, so that we now have measurements on the Platte and all of the tributaries, and a comparison of these results, it is hoped, will bring out new facts in regard to the laws of the return of water. In general, the conclusions of Bulletin 33 have been sustained, and an increase in the amount of seepage water has been found from year to year. The amounts of increase in the different basins bear different ratios to the acreage, but the cause of this difference can not be confidently given at present.

The measurements in detail have often shown a loss along portions of the streams. This is true of the Platte, the Arkansas and the Rio Grande, at least for portions of the streams. This is quite noticeable in sections of the Arkansas and the Rio Grande, so much so in the latter stream that the loss is not yet explained. The matter is of considerable importance, because in it may be involved the large questions of water rights on those streams. On the Rio Grande the measurement was extended for some forty miles above the section previously measured, going up the Rio Grande to the South Park. The greatest loss has been found at the

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rim of the valley. A measurement was also made on the Conejos river, so that we have the principal portion of the streams of the San Luis valley. A measurement was also made on the Uncompahgre from Ouray to its mouth, near Delta, for the first time. These results are summed up in the following tables, all measurements being given in cubic feet per second. The results on the Arkansas river are not worked up at the time of this report:

CACHE LA POUDRE RIVER.

	1900 July-Aug.	1900 Aug.-Sept.
Weir to water works	+5.08	+4.38
Water works to L. and W.	—3.13	+4.15
L. and W. to No. 2 supply	----------	+3.56
Supply to Strauss bridge	----------	+11.49
Strauss to No. 2 canal	—16.84	+1.37
No. 2 to Eaton ditch	+5.63	+3.03
Eaton to No. 3 canal	+6.30	+1.30
No. 3 to mill power canal	+30.17	+21.40
Mill power canal to Camp ditch	+34.29	+24.49
Camp ditch to mouth	+43.39	+34.85
Totals	----------	110.02

BIG THOMPSON CREEK.

	Distance Miles	1900 July	1900 September
Home supply to Barnes' ditch	5.7	+8.18	+8.67
Barnes' ditch to Loveland and Greeley canal	3.1	+6.27	—0.28
Loveland and Greeley to Big Thompson ditch	10.5	—4.63	+9.08
Big Thompson to Hill and Brush ditch	5.3	+7.98	+3.01
Hill and Brush to Big Thompson and Platte River ditch	10.6	+8.80	+5.09
Big Thompson and Platte to the Evans town ditch	11.0	+25.25	+11.50
Totals	46.2	+51.85	+28.07

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LITTLE THOMPSON.

	Distance Miles	1900 September
Eagle ditch to Dry creek	3	+1.91
Dry creek to Rockwell ditch	2	+5.19
Rockwell to Miner & Longdon ditch	3	+3.89
Miner & Longdon to mouth	6	+10.93
Total	14	21.92

ST. VRAIN CREEK.

	1900 October
Lyons to the Oligarchy ditch	—5.76
Oligarchy to the Niwot ditch	+2.85
Niwot to the Boulder-Weld county line	+14.72
County line to Boulder creek	+10.47
Boulder creek to Fleming place	+5.58
Fleming place to Platte river	+8.55
Total	+36.41

LEFT HAND CREEK.

	1900 October
Johnson ditch to Holland ditch	+1.25
Holland ditch to Williamson and Way ditch	+0.39
Williamson and Way to one mile west Burch school	+0.18
Burch school to St. Vrain creek	+6.01
Total	+7.83

From both St. Vrain and Left Hand, 44.24.

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BOULDER CREEK.

	1900 October
Gaging station to Valmont bridge	+13.63
Valmont bridge to Leggett crossing	+ 3.86
Leggett crossing to Boulder-Weld county line	+11.60
Boulder-Weld county line to mouth	− 1.49
Total	+27.60

SOUTH BOULDER CREEK.

	1900 October
Gaging station to Dry creek	+ 0.93
Dry creek to mouth	+ 0.12
Total	1.05

From both Boulder and South Boulder, +28.65.

CLEAR CREEK.

	1900 October
Three-quarters mile above Golden to Rocky Mountain ditch	− 2.48
Rocky Mountain ditch to Slough branch	+ 8.02
Slough branch to Jefferson-Arapahoe county line	+ 4.36
Jefferson-Arapahoe line to Clear creek and Platte river ditch	+ 3.75
Clear creek and Platte river ditch to mouth	+ 2.15
Total	+15.80

BEAR CREEK.

	1900 October
Morrison to Pioneer Union ditch	+ 3.70
Pioneer Union to Jefferson-Arapahoe county line	+ 9.53
Jefferson-Arapahoe line to mouth	+ 2.48
Total	+15.71

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RIO GRANDE RIVER.

	1900 August
South Fork to United States gaging station	+48.15
United States gaging station to Del Norte	−25.95
Del Norte to Off's	+21.69
Off's to the Prairie canal	−10.05
Prairie canal to Monte Vista bridge	− 3.24
Monte Vista to San Luis canal	+21.89
San Luis canal to Hickory Jackson ditch	+13.78
Hickory Jackson to Alamosa	+ 0.14
Alamosa to above mouth of Conejos river	+ 0.24
Above Conejos river to below mouth of Conejos	− 0.35
Below mouth of Conejos to Los Sauces	+ 1.75
Los Sauces to Iron bridge	− 5.09
Total	+62.96

The first section above given has been measured for the first time in 1900, and, in comparing with the results of previous years, should be left out of account.

CONEJOS RIVER.

	1900 August
Gaging station to San Juan bridge	+ 2.09
San Juan bridge to Conejos bridge	−22.12
Conejos bridge to Cerritos	+ 0.30
Cerritos to San Antonio creek	− 1.02
San Antonio creek to McIntire place	+ 6.65
McIntire place to McIntire Springs	+ 3.00
McIntire Springs to mouth	+ 6.88
Total	− 4.22

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UNCOMPAHGRE RIVER.

	1900 November
Bachelor mine switch to 11th correction line	+1.10
Eleventh correction line to Ridgeway	+23.28
Ridgeway to 6½ miles below Ridgeway	—2.65
Six and one-half miles below Ridgeway to Ouray-Montrose county line	+11.10
Ouray-Montrose county line to Stark bridge	+10.23
Stark bridge to Montrose	—0.09
Montrose to mouth of Spring creek	+19.43
Spring creek to Olathe	+15.97
Olathe to Boles & Manny ditch	—4.04
Boles & Manny ditch to mouth	+14.23
Total	+88.56

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REPORT OF THE ARKANSAS VALLEY SUBSTATION.

The policy of the sub-station this year has been different from that of former years, in that less work has been attempted upon the property belonging to the station, thus relieving the superintendent of many of the duties connected with the farm, and enabling him to apply much of his time to observations and investigations in different parts of the valley.

The superintendent has visited the valley from Pueblo to Holly, and has put in approximately one-half of his time in this outside work. Two visits were made to points east of La Junta, one to Pueblo, three to Ordway, and much time given to observations at points between Manzanola and La Junta.

The principal field work of the season has been done with the cantaloupe and sugar beet, giving some attention to questions relating to the tomato. Attention has been given to matters of minor importance in so far as it might give us an insight into the work of the future.

The operations on the station proper have included work with the following: Cantaloupes, sugar beets, tomatoes, legumes for green fertilizers, pasture plants, potatoes, wheats, care of experimental orchard, codling moth (in orchard of Mr. Crowley), meteorology, and distribution of seeds.

The 200 acres controlled by the station have been leased the past season to four different parties, except about fifteen acres reserved for experimental purposes. From the leased land some information of experimental value has been secured, besides a considerable revenue, lessening the net cost of the sub-station by about $1,000.

CANTALOUPES.

The experiments with the cantaloupe have included the following lines of work:

1. Noting the amount and distribution of the blight.

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2. Use of the Bordeaux mixture in the control of the disease.

3. The proper times and amount of spray.

4. Effect of the Bordeaux upon the quality of the fruit.

5. Potassium sulphide as a spray for control of the blight.

6. Cross fertilizing of the cantaloupe with its own pollen; also with that of the cucumber, pumpkin, squash and watermelon.

7. Effect of seed selection.

Observations were made over the valley from Pueblo to Holly for the purpose of noting the distribution of the blight. At every place visited, except Pueblo, we found the disease prevalent. There seemed to be no uniformity in regard to the extent to which the disease attacked the fields. Severe cases of it were seen in almost every locality.

The results with the use of the Bordeaux have confirmed those of last year, as reported in Press Bulletin 4 and in the local press. Upon the station about five acres were used in the spraying experiments, together with four acres sprayed for Mr. Deweese, all of which were comparable with adjoining fields. In addition to the above we had under observation four fields sprayed by farmers. Two early sprayings were given two acres on the station, and the same were given those of Mr. Deweese. One acre on the station was sprayed once, quite late in the season, and a small area was given three sprayings. Those under observation outside were given from one to three sprayings.

The season was not a favorable one for the spread of the disease. The summer was extremely dry, and in many places the blight was not severe enough to injure the vitality of the plant, hence the results are not so marked as they would have been had the weather been more moist. However, on the station, the benefit to the vines was quite apparent, but the most benefit does not lie in the visible preservation of the vines so much as in the preservation of the quality of the fruit, together with the manner in which the fruit ripens.

The parties picking the cantaloupes on the station saw a marked difference in the time and manner in which those on the unsprayed vines ripened, as compared with those sprayed. Unsprayed melons ripened rapidly, and the ripening period was two weeks shorter than when sprayed, the

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difference in quality corresponding in the same degree. The remark was made by many who saw the sprayed portion: "How nice and green your vines appear!" They were strong and healthy to the time of frost.

In every instance, those under observation confirmed the results of the station in a greater or less degree.

Observation shows that this disease often impairs the vitality of the vine and reduces the quality of the fruit, when it does not appear to have spread to an injurious extent. The cultivator may not even be aware of its presence.

One row 500 feet long was sprayed with potassium sulphide in water, at the rate of one pound to fifteen gallons of water, at which strength it burns the foliage without any apparent value as a remedy for the disease.

One hundred and ninety-five crosses were made in our study of cross fertilizing as above mentioned. We were successful in securing three fruits of the cantaloupe crossed with its own pollen, and a cross of the pumpkin upon the cantaloupe. In the other attempts there was no success.

Three grades of seed were used in a test of the effect of seed selection upon the resultant crop. The results show a difference of seven per cent. in the amount of first-class fruits between the first and third-grade seeds.

SUGAR BEETS.

Observations and experiments upon the following subjects have been made with the sugar beet:

1. Time and manner of planting to secure a stand.
2. Use of various implements in overcoming the formation of a crust over the young plant.
3. Time and amount of irrigation as affecting yield and quality.
4. Depths of planting.
5. Sub-soiling.
6. Effect of seed selection upon the resultant crop.
7. Kinds of insects infesting beets and remedies for their control.

The earliest planting of which I am aware was done on April 9. The weather conditions during April were unusual. During the month 7.16 inches of rain fell, which was well distributed, the weather remaining comparatively warm and

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favorable to germination. So much rain fell during April and May that but little irrigation was required for germinating the seed, hence there was little difference in the manner of planting. In most instances good stands were secured, and where failure resulted it was more often due to deep planting than to any other cause.

The greatest difficulty the farmer had to overcome this year was the formation of a hard crust upon the surface of the soil, through which the young plants could not penetrate. To destroy this crust with the least injury to the plant and soil was, then, the problem. The implements used for the purpose were the roller, light harrow and spider-feet of the beet cultivators.

Comparison of the different implements has shown that the harrow is the most efficient, used in the early morning when the soil is damp. Rolling the crust has a tendency to bruise and injure the young plants. A comparison of the two methods shows much better stands from the use of the harrow.

In most cases two or three irrigations were required for the maturing of the crop. Upon a four-acre field, of uniform fertility, of the station, we had an opportunity to study what effect the amount of irrigation may have upon the tonnage and sugar content.

This field was first irrigated from the fifth to the eighth of July; a second time from August sixth to tenth. A portion of the field was irrigated for the third time on the sixteenth of August. The latter yielded at the rate of seventeen and one-fourth tons per acre, while the remainder gave but eleven and three-fourths tons per acre.

The highest percentage of sugar with two irrigations was twenty per cent., and the lowest fifteen per cent. The three irrigations showed seventeen per cent. the highest, and fifteen per cent. the lowest. The results would seem to indicate that the tonnage may be appreciably increased by the judicious use of water without a corresponding decrease in the sugar content, but the maturity of the beet will be retarded, which fact must be taken into consideration.

For the purpose of testing to what depth planting should be done to secure the best results, five plantings were made, respectively, one, one and one-half, two, two and one-half, and three inches in depth.

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The depth of covering was so gauged that perfect accuracy was obtained and the results are as follows:

With the one and one and one-half inch plantings perfect stands were secured; and with the two inch planting one-half a stand. A few plants came up at two and one-half inches, but deeper than this none appeared. Germination was secured by rainfall, so that the conditions were uniform, and the results are positive as to the depth to which beet seed should be planted.

Two years ago beets were selected that analyzed from seventeen to twenty-three per cent. of sugar for the purpose of planting, to note the effect of seed selection upon the future crop. Seed was grown from them last year, and this season it was sown. Samples were taken at different times for analysis of those grown from parent beets, showing seventeen and twenty-one per cent. of sugar.

The results are disappointing, in that there was no special difference in the sugar content of the different samples. The results would indicate that perhaps more depends upon proper care and cultivation than upon seed selection, where, as in this case, both selections are made from high-grade beets.

The sugar beet has not been free from the attacks of insects, viz., the grasshopper, leaf-roller (*Agallia*), false chinch bug (*Nysius*), two species of cutworm (alfalfa worm), blister beetles, and beet army-worms. The most serious damage was done by the leaf-hoppers and beet army-worms. The former did more or less damage the whole season, but not of a serious nature. The latter appeared about the middle of June, and threatened for a time to destroy some fields.

Observations were made upon sprayings performed with Paris green and water (one pound to 75 and 100 gallons), and with white arsenic (one quart of the solution to fifty gallons); also upon the use of Paris green and flour mixture to dust the plants.

I conducted some trials with Paris green and water (one pound to fifty gallons), to which was added one pound of soap; also the use of a quart of strong kerosene emulsion to the barrel of water. The soap proved to be a valuable addition to the Paris green spray, as it made the poison adhere to the leaf and distributed it more evenly over the surface. The work of the season showed that the Paris green spray must be used as strong as one pound of poison to fifty or seventy-five gallons of water for success.

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The arsenical solution was quite effective, and considerable benefit was derived from the dusting; but the plants are not well covered by the latter method, besides it is too expensive. The use of the poison and soap mixture completely destroyed the worms in the field in less than three days.

TOMATOES.

The following lines of investigation have been under way with the tomato:

1. Field planting vs. transplanting.
2. Early and late transplanting as affecting yield and ripening.
3. Transplanting in the field.
4. Early and late pruning as affecting production and ripening.

The above work was of a preliminary nature. There is a considerable failure on the part of the tomato to fruit, and the experiments were planned looking to a study of the cause. Many are the reasons ascribed, but careful experimenting proves that not all the theories put forth are correct. The yield was not nearly as good from the field-grown plants as from the transplanted ones.

Early transplanting gave much better results than late, and no benefit was secured from transplanting in the field. No benefit was derived from the pruning, except possibly a few tomatoes ripened a few days earlier on the late pruned vines.

LEGUMES.

The work of testing leguminous crops for green fertilizers has been continued with the following plants: hairy vetch, cow pea, and soy bean. Three plantings of the hairy vetch were made in the fall of 1899, for the purpose of testing the time at which it may be sown in the fall and make a fertilizer for the succeeding year's crop. The plantings were made August 31, September 26, and October 10. The planting of August 31 stood about two feet high by the twelfth of May and commenced to bloom. The planting made the twenty-sixth of September was about one foot high by the twelfth of May and would have made splendid pasture. The area devoted to these two sowings was six-sevenths of an acre, from which 3,000 pounds of straw and seed was har-

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vested, besides a vast amount of aftermath remaining on the ground. The yield of seed was 300 pounds. This plant promises to be a valuable acquisition to the agriculture of this section as a forage plant, a green fertilizer, for bee forage, and as a soil binder in the spring. We now have it in such a position that we will be able to secure comparative results with it as a fertilizer another year.

The splendid results secured where alfalfa is employed as a fertilizer show the necessity and advisability of employing nitrogenous crops as fertilizers for this soil. The many places where alfalfa can not be used compels the use of some other legume.

The cow pea is a valuable plant for green fertilizing, as well as for its grain. About one acre was grown this year, but at present the threshing is not completed and yields can not be reported. Root tubercles were plentiful upon both this plant and the hairy vetch, and the amount of vegetable matter left upon the ground after harvesting is such as to commend them to all who wish a soil improver.

The medium soy bean grows and bears well, and its fertilizing value to the soil is no inconsiderable amount. Unfortunately, we have not been able to thresh out the grain to show what it produces, but I estimate it will yield from fifteen to twenty bushels per acre. This is such as to warrant its growth for grain and forage, in addition to the fertility derived.

PASTURES.

The testing of grasses for pasture has been continued. Those under observation the past year were orchard grass, brome grass (*bromus inermis*), perennial rye grass, and a sowing in August of the fall meadow oat grass. The first mentioned has proven its adaptability to this section. It resists drought, makes good growth, and cows pastured upon it do well. The bromus has proven to be of no value to this section. It makes some growth in the early spring, but does not withstand the heat of summer. Pasturing shows it to have but little nutritive value. The perennial rye grass has been under observation only one year, but it gives promise of good results. The growth is good and a heavy sod is formed. It remains green during the hot summer, and stock eat it with avidity.

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POTATOES.

We have continued some investigations to gain further information as to why this crop is not a success in this section. The past year has shown that to the climate to the greatest degree, and not to the soil, must be ascribed the failure. The work on the station was a comparative one as to the manner of planting. Alfalfa sod was selected for the purpose, which was fall and spring plowed. About three weeks before the time of planting, half of the land was irrigated and when dry enough was plowed, and the seed planted in the furrow. The other half was planted and afterwards irrigated in furrows. The purpose of this was to note the effect upon the crop of the different means of germinating the seed.

Equally good stands were secured on each section, and the treatment throughout the season was the same. The summer was extremely hot and dry, and both sections were entire failures.

Observations of other fields that were comprised of low-lying, sub-irrigated lands, which gradually merged to that which was higher, dryer and more sandy. revealed the cause to which success or failure is due. Upon the low, wet land, where cool conditions could be maintained, somewhat satisfactory results were secured; while, on the other hand, where such conditions could not be obtained, the result was a failure.

WHEAT.

The varieties of wheat recorded in the report of 1899 as being sown in a field way were turned over to the leasers, hence complete records could not be secured. Some of the same varieties were duplicated in small plats in an experimental way, and from observations of their growth and behavior we have discarded all but two varieties, viz., Ruby and Defiance. In a field way the latter yielded sixty-seven bushels from 2.7 acres of land. The seed was sown the latter part of January.

Both of the above varieties are either spring or winter wheats in this section, and the possibility of their being sown so late makes them especially desirable kinds. Often, weather conditions and water supply are such that wheat can not be sown early in the fall, but favorable conditions

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may prevail at winter periods. This is many times an advantage to the farmer. In point of yield and milling properties these varieties have no superior among those tested. Of the strictly winter wheats, the "Hunter's Winter" was the most desirable one tested. It ripens about the twenty-fifth of June, and thus is harvested before hot weather occurs, which is apt to shrivel the grain and reduce the yield. From one pound of the "Defiance" seed, eighty pounds of grain were secured, and from one pound of "Ruby," seventy-nine pounds of grain.

ORCHARD.

Many of the trees in the old orchard have shown that they were not adapted to this section, and for that reason they have been cut down. The varieties of apples remaining are the Duchess, Ben Davis, Early Harvest, Whitney No. 20, Wealthy, Kirkbridge Early White, Red Astrachan, Salome, Saps of Wine, Missouri Pippin, Walbridge, Utter's Red, Bellflower, Arkansas Black, Northern Spy, McIntosh Red and McMahon's White. Some trees that failed to grow in the new orchard have been replaced, and to these have been added some new varieties for testing. Very good growth of all kinds has been made. There still remain some vacant places that should be filled by new and promising kinds.

ENTOMOLOGY.

In connection with the section of entomology considerable work has been done with the codling moth. For this work the Hon. J. H. Crowley kindly placed at our disposal such trees as were desired. Complete notes were kept and the records furnished Prof. Gillette. Bearing trees in the station orchard were used in a study of the percentage of worms remaining in the apple at the time of harvest, and a further study of the percentage of wormy apples on the trees at harvest time.

The records now contain the results of three years' work, along different lines, in a study of this insect, and give us some information desired by the horticulturist as to its habits and control.

METEOROLOGY.

The meteorological observations have been continued and reports made to the weather bureau, section of meteorology, and the local press. Some of the back records have

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been compiled and use made of the same by parties interested in beet culture.

SEEDS.

As the policy of the station has been to distribute the work over the valley and to give the tests as wide a range as possible, some co-operative tests with farmers were inaugurated with different field crops. For this purpose the following kinds of seeds were distributed and reports will be collected: Cow peas, soy bean, coffee pea, White Kansas, Iowa Silver Mine, and Golden Beauty corn; cantaloupe, and hairy vetch.

Eighteen parties received seed. The objects for which they have grown them are: fertilizer, forage, cover crops, grain, bee forage, and test of the distribution of cantaloupe blight.

FEEDING.

Late in November arrangements were made for the feeding of sheep on sugar beet pulp.

The principal object of the feeding is a comparison of the pulp with corn as a fattening food for sheep, and the establishment of a value for the former with the latter. About 250 head will be fed.

Respectfully submitted,

H. H. GRIFFIN,
Superintendent.

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REPORT OF THE PLAINS SUB-STATION.

In the main, the work was carried out as it was planned.

Weather—A very heavy rainfall in April soaked the soil to a depth of from three to six feet. The rainfall in the succeeding months was light and poorly distributed for the growth of crops. A record of temperature, wind, rainfall and relative humidity of the air has been kept throughout the year, as in previous years. I have also acted as a volunteer weather observer for the United States weather bureau.

HORTICULTURE.

All fruit trees made a good growth this year. Three apple trees blossomed. One Duchess of Oldenburg, which was located where no extra water could reach it, matured two apples, which were fine specimens. Two Missouri Pippin trees blossomed, but only one matured fruit. It produced fourteen mature specimens of medium size. These Missouri Pippin trees are located where they get some water from the prairie, and the one which matured fruit is so near the house that some waste water was given it.

Plums—Several varieties blossomed. Some extra fine fruit was produced, but no trees bore what could be called a good crop. Some of these trees were set in 1894 and some in 1895, and the record is so incomplete that we can not give the names of the varieties which produced fruit. Of the varieties set in 1897—three each of Weaver, Rollingstone, Wolf, Cheney and American Eagle—one Wolf tree is dead, but two Wolf plum trees bore some fine fruit; one Cheney tree also bore some good specimens; the other three varieties bore no fruit. The wind caused considerable loss of fruit.

Cherries—Early Richmond, Early May and English Morello trees bore good crops. One small English Morello tree was so loaded that the leaves were scarcely visible. The common Morellos bore a small crop, while the Rocky Mountain cherries were loaded, as usual, with fruit, which is of doubtful quality. They appear to be the same as the dwarf cherries found growing on the chalk hills upon the plains.

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Cultivation has increased the size, and selection has reduced the bitter principle, but the main characteristics of the choke cherry remain.

Gooseberries—The Downing and Houghton gooseberries both bore good crops.

Apricots—The Russian apricots set in 1899 all lived and grew well this year. None bore fruit.

Peach Trees—Twelve of the nineteen peach trees set in 1899 are still alive. Twenty-four more were set this year, but, on account of an accident at the time of setting, only a few lived.

Dewberries—In 1899 fifty each of Lucretia and Mammoth dewberries were set on the north side of a sod wall, where much moisture collects. Twenty of the Lucretia and five of the Mammoth plants lived. Some fine fruit was produced by the Lucretia plants this year. A few blossoms were seen on the Mammoth plants, but no fruit matured properly. The Lucretia plants have spread like they considered themselves at home.

Blackberries—Of the one hundred and fifty plants set in 1899, only a few are now alive. These are not thrifty.

Raspberries—None of the plants set in 1899 are now alive. The old stock of Cuthbert raspberries set in 1894 continue to live, but they have never borne more than a few berries any year.

Crabapples—All but one of the crabapple trees set in 1899 are alive. They have made a good growth.

Pears—The six dwarf pear trees set in 1899 have made a small growth, and are still in good condition.

FOREST TREES.

The ash, black locust and Russian mulberry trees, which were planted around the orchard in 1895 now make quite a good wind-break, although they are sixteen feet apart. The black locust, ash and box-elder, which have grown from seeds planted in 1897, are still thrifty. Of the thirty varieties of seed planted in 1899, only black locust, honey locust, walnut and coffee bean have grown. Nearly all these germinated in 1900.

Russian Mulberries—In 1897 we planted five rows of Russian mulberries across the field at intervals for windbreaks. Observation has shown that the harm they do or-

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dinary crops by taking up the moisture outweighs the benefits derived from their use. I have found the roots of a Russian mulberry, which was not more than six feet high, fifty feet from the shrub to which they belonged. One row was grubbed out in 1900. The others should be grubbed as soon as convenient.

The following table gives result of the tree planting done in 1899:

Variety.	No. Planted in 1899.	No. Alive Oct. 1, 1899.	No. Alive Oct. 1, 1900.
Elm	100	43	43
Honey locust	1,000	424	331
Ash	1,000	414	378
Catalpa	100	90	77
Wild black cherry	100	16	11
Russian wild olive	10	10	10
Russian apricot	12	12	12
Pear (dwarf)	6	6	6
Cherry (cultivated)	6	4	4
Crabapple	10	9	9
Peach	19	12	12
Prune	5	1	1

Garden—A small garden was quite productive. Beans, peas, radishes, lettuce and onions from sets did well. We have failed, always, to raise onions from seed.

Potatoes—One-half an acre of Early Ohio potatoes was planted. These, in common with nearly every potato patch in eastern Colorado were almost an entire failure. The cause was an attack of potato beetles (*Meloidae*), followed by prolonged drought.

Sweet Potatoes—Two hundred plants were set. They yielded at the rate of ninety bushels per acre.

Melons—Several varieties of watermelons and muskmelons were planted. Cutworms did much damage when the plants were small. The vines which lived bore fair crops. The coyote is one of the worst enemies with which the watermelon grower has to contend. Coyotes are as fond of ripe watermelons as piccaninnies are said to be.

Squash—Several varieties were planted. Squash bugs took all the vines that the cutworms left.

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Cucumbers—Cucumbers produced a good yield. They were not attacked by any enemies, and have proved to be one of the most profitable of all garden crops.

Sweet Corn—Maule's First of All, Nonesuch, Country Gentleman were planted. This gave a long roasting-ear season. Each variety produced a light crop, on account of lack of rain at a critical time.

Popcorn—White Pearl was the only variety planted. It produced a good crop of corn, and the largest crop of corn fodder which was grown on the place this year.

Flowers—Sweet peas, nasturtiums, portulacca, hardy phlox, cosmos, marigolds, oxalis and balsams were planted where waste water from the house could be given them in time of need. It was used on all except the balsams, which seemed to do well with only the natural rainfall. In order to obtain the greatest possible benefit from the water, it was usually applied warm, and was poured into trenches beside the plants. Then, as soon as the water had soaked into the soil, the trenches were filled with loose, dry earth. The sweet peas bore enormous crops of flowers and all the other varieties did well. The cosmos did not begin to produce flowers until October 1. The plants were a blaze of blossoms from that time until killed by the freeze, October 30. They successfully withstood a temperature of 26 degrees F. These were photographed, and photographs will be filed later.

FIELD CROPS, 1900.

Canada Field Peas—A small plat of Canada Field Peas was planted. The yield was so light that they were not harvested.

Cow Peas—Taken by grasshoppers. This is the first time we have failed to raise cow peas here.

Tree Beans—Taken by grasshoppers.

Oats—One variety of oats, U. S. No. 2788, was sown April 14. The yield was eighteen bushels per acre.

Wheat—One variety of spring wheat, U. S. No. 2953, was sown April 14. The yield was ten bushels per acre.

Grass—Bromus inermis, Agrophyrum tenerum, Agrophyrum cristatum (seed furnished by the United States department of agriculture) were sown April 3. Very little germinated. None can be found on the plats now. Paspalum dilatatum (Australian seed) also failed to grow.

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Bromus Inermis—Seeded in 1898, on a two-acre plat; still shows a good stand on about four square rods. Some of it grew sixteen inches high this year. We have left all parts of the plat where any grass shows, in order to give the grass a chance to spread and become thicker, as it is supposed to do. We can not see that it is any thicker than it was a year ago.

Sand Vetch—A plat of Vicia villosa was planted. The seed was furnished by the United States department of agriculture. A good stand was obtained. Twice before we have obtained stands of Vicia villosa, which were destroyed by accidents before the merits of the plant could be tested. But this is in a place where it can be left, undisturbed, indefinitely.

Hagi—Seed furnished by United States department of agriculture. It was planted April 24. A few plants, which closely resemble Lespedeza, native in central Kansas, have been obtained. They are now about a foot high.

Flax—One-half an acre of Russian flax was planted this year. A few feet of row was planted in 1898, and the same amount in 1899. Both these trials showed well-filled bolls. The plat this year produced a yield of eight and one-third bushels per acre. It was planted April 4 on ground plowed five inches deep and carefully prepared. It was cut July 9.

Alfalfa—The one-half acre of alfalfa sown in 1897 and two acres sown in 1899 were cut May 30, yielding about one-half ton per acre. The same ground was cut over again July 9, and a crop of Russian thistles taken from it. These are stacked for use during the coming winter. After this crop was taken off a part of the ground was disced to cultivate the alfalfa. So far, we have seen very little result from the summer discing. We feel sure, however, that the disced portion was not injured by the treatment.

Sorghum—Nine varieties of sorghum were planted in large plats. An accurate account was kept, showing the time spent in planting, cultivating and harvesting. All were planted with a lister drill, May 4 to 10, and were given careful field culture, consisting of harrowing and plowing at such times as seemed necessary when following rational farm practice, the object of which is to make the crop pay, financially. Once, on account of not being able to cultivate at the right time, a part of the crop became so weedy that the weeds had to be cut out with a hoe. This increased the ex-

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pense, but it is included in the estimate of expenses, because such things frequently happen in farm practice.

The cost of producing one acre of sorghum and putting it into the shock was:

Labor of man and team, per acre	$2 07
Three pounds of seed at 2 cents, per acre	06
Feed of team and wear of tools, per acre (estimated)	25
Total cost per acre	$2 38

Only twenty-five acres were planted. By raising it on a larger scale, we believe that the cost would be considerably reduced.

The seed of Early Amber, Colman, Edgar and Folger's Early was furnished by the United States department of agriculture. The other varieties were bought from seedsmen. The following table shows the yields of the varieties:

Name	Yield of Fodder Per Acre, Pounds	Yield of Seed
Early Amber	2,178	Very little seed
Collier	1,971	No seed
Edgar	2,430	No seed
Colman	3,132	No seed
Folger's Early	4,095	No seed
Early Orange	2,394	No seed
White African	2,700	No seed
Kansas Orange	3,591	Considerable seed
Early Minnesota	2,835	Considerable seed

The following table gives the results of some sorghums grown in small plats:

Name	Yield of Fodder Per Acre, Pounds	Yield of Seed
Honey Dew, from U. S. department of agriculture	5,400	Good yield of seed
Chinese, from U. S. department of agriculture	5,400	Seed badly mixed
No. 161, from U. S. department of agriculture	5,000	Much seed ripened

Early Amber, from Joseph Ruby, Thurman, Colo., planted June 7; ripe September 1.
No. 939, from U. S. department of agriculture, planted April 24; ripe August 20.

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No. 939 is from seed obtained in northern Siberia. It grew but little leaf and a hard stalk.

Black-hulled white Kafir corn was planted May 10. A poor stand was obtained. It matured no seed, but grew tall, and made very thick, heavy stalks. The yield was estimated at 1,245 pounds per acre.

A small plat of Brown Durra was put in on plowed ground with a planter drill. It was so thick in the row that it made very small heads and a heavy weight of leaves. The yield of fodder was estimated at 2,000 pounds per acre. The yield of seed was not estimated.

CORN AT THE PLAINS SUB-STATION.

The full record of the corn trials at the sub-station are here inserted, to make the record of the crops as given in the last annual report complete. The tests have been as follows:

1894—Four varieties, planted May 10 to 16: Will's Gehu, failure; Pride of the North, some fodder; Queen of the Field, fodder; White Australian, fodder.

1895—Eight varieties, planted from May 23 to 25: Pride of the North, a good yield of fodder; Early Sanford, Red Cob Ensilage, Reiley's Favorite, Leaming 90-day, Goddard's King of the Early, Early Mastodon and Colorado White, fodder.

1896—Twelve varieties, planted May 18 to 26: Will's Gehu, a few nubbins; the remaining varieties fodder only—Pride of the North, Queen of the Field, White Australian, Early Sanford, Colorado White, White Kansas King, Eclipse, Giant Long White Flint, Imperial Leaming, Early Butler and Early Thompson.

1897—Planted from May 15 to 17.

Variety.	Yield Per Acre.
Will's Gehu	6.19 bushels
Pride of the North	4.90 bushels
Queen of the Field	12.80 bushels
White Australian	9.10 bushels
Early Sanford	22.00 bushels
Reiley's Favorite	22.68 bushels
Colorado white	2.00 bushels
White Kansas King	4.00 bushels

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Variety.	Yield Per Acre.
Eclipse	7.80 bushels
Gt. Long White Flint	7.70 bushels
Imperial Leaming	6.60 bushels
Early Butler	5.00 bushels
Snowflake White	7.70 bushels
Pearl White	10.30 bushels
Giant Mexican, fodder	fodder
Longfellow	19.10 bushels
Minn. White	19.30 bushels
Minn. King	11.90 bushels
Drought Register	9.80 bushels
Iowa Gold Mine	11.60 bushels
Negro Equality	3.80 bushels
Rustler	16.70 bushels
Mercer	18.70 bushels
New Leaming	9.90 bushels
Murdock's 90-day	10.60 bushels
Champion Early White Pearl	8.90 bushels
Extra Early Huron	9.30 bushels
Angel of Midnight	7.50 bushels
Golden Beauty	9.20 bushels
Early Huron	8.50 bushels
Houghton's Silver White	11.80 bushels
South Dakota Flint	6.00 bushels
Brazilian Flour	1.30 bushels
North Dakota Flint	8.80 bushels
Swadley	9.10 bushels
Early Eclipse Yellow	1.50 bushels
King Philip	6.60 bushels
Squaw	7.80 bushels
Canadian Yellow Dent	5.70 bushels
Wh. Cap Yellow Dent	6.50 bushels
Waushakum Yellow	6.90 bushels
Wisconsin Early White	2.50 bushels
Evergreen Sw., fodder	720 pounds
Southern Ensilage	2070 pounds
Giant, fodder	2160 pounds
Superior, fodder	2052 pounds
Elephant, fodder	1494 pounds

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Variety.	Yield. Per Acre.
Early Ripe, fodder (some seed)	2538 pounds
Early Yellow Rose	.50 bushel
Dakota Dent	6.40 bushels
Parson's White	8.20 bushels
Golden Row	15.40 bushels
Star Leaming	6.90 bushels
Queen of the North	5.60 bushels
1898—Planted May 21 to 23—	
Pride of the North	12.0 bushels
Queen of the Field	12.3 bushels
Mercer	14.0 bushels
New Leaming	10.8 bushels
Murdock's 90-day	10.0 bushels
Golden Beauty	8.6 bushels
Early Huron	4.5 bushels
Houghton's Silver White	13.1 bushels
South Dakota Flint	8.6 bushels
North Dakota Flint	15.0 bushels
Swadley	13.0 bushels
King Philip	13.4 bushels
Squaw	12.3 bushels
Canadian Yellow Dent	9.6 bushels
Best home grown mixed (planted on packed ground)	12.7 bushels
Best home grown mixed (planted on unpacked ground)	10.7 bushels

1899—Planted May 15. Three varieties: Pride of the North, 3.0 bushels per acre; Best Home-Grown Mixed (planted on packed ground), 3.0 bushels per acre; Best Home-Grown Mixed (planted on unpacked ground), 2.7 bushels per acre.

1900—Six acres were planted May 4 to Salzer's Earliest Ripe fodder corn. It tasseled when it was from three to four feet high. The yield of fodder was very light, and it produced only about four bushels of grain per acre.

SOIL MOISTURE.

So much rain fell during April that the ground was wet to from two feet and ten inches to more than six feet. It was thought desirable to observe the movement of the moist-

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ure during the season, so twenty-seven places were marked for observation—these representing a great variety of local conditions concerning the amount of water which could collect at the different locations. Observations were taken by boring and examining the soil by feeling it with the fingers. While this is not a delicate test, yet when no moisture can be felt in the soil by the fingers, plants do not do well when growing in it. So, for practical purposes, we considered it of some value.

The plan was to take observations twice each month during May, June, July and August; but other work interfered, so that only three observations were taken. These were taken May 1, July 28 and August 22. The auger used was only six feet long, so at the first test there were six places where the auger did not reach dry soil. Leaving these and others concerning which the records show incomplete tests out of the calculation, the test showed:

May 1—Moisture from the surface to 3 feet.....2.3 in. av.
July 28—Moisture from 6 inches below surface to 4 feet.....2.6 in. av.
August 22—Moisture from 9.7 inches below surface to 3 feet.....2.6 in. av.

INVESTIGATION OF EASTERN COLORADO.

This work was done by traveling about the country in a spring wagon. During the summer we traveled more than thirteen hundred miles. Settlers were interviewed and their evidence recorded. The investigation was confined mainly to Kit Carson county and the eastern half of Arapahoe county. Stock raising is the main business in all communities, except near Vernon and Idalia. Small herds occupy the uplands, where water is scarce. The large cattle companies are confined to the valleys, where water is plentiful. Those keeping small herds usually raise feed to carry their stock through the winter storms. But nearly all stockmen prepare to feed the weak animals. Near Vernon and Idalia wheat raising is still the main business, and some seem to have done well. Some alfalfa is raised in the valleys of the Republican, but nowhere on an extensive scale. Native hay is cut every year in the valleys, and on the uplands about two years in every five.

Those parts of the country where water is readily found by digging or boring have held the settlement, but where water is hard to find the country is deserted.

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Fruit—Hundreds of orchards have been set out, but now there are only a few trees here and there. It has been found that cherries, plums, gooseberries and wild currants can be grown on the uplands with moderate success. Some apples, peaches and grapes have been produced, but these have generally failed.

Forest Trees—The remains of timber claims show that the ash, the honey locust and the black locust are the best trees for groves on the uplands. But some groves of black locust have been destroyed by borers. I have found elm trees doing well where they were planted among other trees.

Utilization of Natural Conditions—The best example of this is at the place of James Howell, which is seven miles northeast of Flagler. This place is located on a small stream. The side hills have been planted to trees, and large pits dug above each tree to catch the storm water for the trees. The creek has been damned, its course turned out of the natural channel and trees planted in the old creek bed. The seepage from the pond above sub-irrigates the trees below. Also, a pond is located on the side hill, above the fruit garden, so it will catch some storm water from the prairie. Groves and hedges of black locust form windbreaks about the orchard and lots. A well, located at the upper end of the garden, is used at times to water some plants. I saw grapes, currants, apples, cherries, gooseberries, plums and walnuts at the place. Some trees were loaded with fruit.

Irrigated Places—The small irrigation plants are too numerous to mention. The majority are run for comfort, but a few are conducted for profit, and with success. The increase of herds depending upon the same well, which once watered the garden, has caused the abandonment of many successful small gardens on the uplands.

Irrigation Ditches—One small ditch in the valley of the north fork of the Republican supplies several hundred acres with water. The Arickaree seems to be used very little for irrigation on account of the sandy nature of most of the valley land. The valley of the south fork of the Republican has several small private ditches, which are doing good work. Two large ditches, which were built several years ago by a company, seem to be unused now.

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Upland Farming—Crops—Where stock raising is the main business, sorghum is one of the favorite crops. It will average one ton per acre.

Millet gives a smaller yield than sorghum, but it is a favorite forage crop with many.

Broom corn is quite a sure crop, but uncertain demand prevents extensive planting.

Corn is generally planted. The yield for the whole region will not exceed ten bushels per acre.

Oats will not give an average yield of more than ten bushels per acre over the whole region. They are sown for hay by many.

Wheat is the most popular of small grains. Yields of from nothing to forty bushels per acre have been reported. The general average per acre for the whole region is probably about six bushels.

Barley is but little grown. Many consider it the surest crop which has been tried. Yields of eighty-three bushels per acre have been reported. The average yield per acre is near fifteen bushels for the region. Barley is used mainly as feed for stock. Very little is raised for market.

Rye is but little grown. The yield will not usually exceed ten bushels per acre.

Flax has been successfully produced, but low prices and occasional failures caused production to cease.

Other forage plants used extensively are native grasses, which furnish hay; Russian thistles (which were the subject of a press bulletin, issued by the Colorado experiment station in July, 1900), and native salt weed.

SOIL STUDY.

As I traveled I observed the soil, and took some samples which seemed to be types. These are stored for future use. An extended report of my work in this line is on file in the director's office.

CULTURE AND METHODS.

The feeling is general that no method of planting or cultivation is sure to produce a crop. Also, experience has

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shown that the soil is so rich that when there is sufficient rainfall, properly distributed, a large crop will be harvested, no matter how it is planted and cultivated. Some soils maintain a soil mulch on the unbroken land in dry times. These are well fitted to give a maximum crop for a minimum amount of labor.

CONCLUDING OBSERVATIONS.

1. Nature seems to have fitted this country for a grazing country.

2. Crowded conditions in other places have compelled people to settle here, where conditions of life are hard; and after trying it, those who are still here claim that they know of no place where they can do better, so they intend to stay.

3. General crop failures and small returns for grain raised have driven the settlers to make stock raising their main business.

4. As the range becomes crowded with small herds, it will be impossible for all to keep enough cattle to maintain themselves by raising beef alone. Then the dairy business must develop, and natural advantages will be utilized to help out the living.

5. Windmill irrigation must be more largely used on the uplands, and all the water of streams (underflow, flood waters and ordinary flow) will probably be used at some time in the future.

RECOMMENDATIONS.

1. The investigation should be continued.

2. A study of native hay and pasture grasses should be undertaken with a view to extending the range of those of special merit, wherever possible.

3. Windmill irrigation should be studied and settlers assisted by teaching them to improve their methods, wherever possible.

4. The plants where storm-water reservoirs are used for catching water from the prairies should be watched, and their projectors encouraged.

5. The distribution of the native salt weed should be determined, and if it is found a profitable crop its limits should be extended.

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6. A special study should be made of the three valleys of the Republican river, the Big Sandy and the sand hills of eastern Colorado.

Respectfully submitted,

J. E. PAYNE,
Superintendent.

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METEOROLOGICAL OBSERVATIONS, 1900.

The following tables, prepared by Mr. R. E. Trimble, give a record of the principal observations made during 1900, and especially the ones which are most often inquired about. Records have been maintained at Fort Collins nearly regularly since 1884, besides 1873 and 1874. The record has been maintained to give not only the elements ordinarily included in weather observations, but a number of those important in agricultural meteorology, but less often recorded. Among these special attention has been given to the sunshine, measuring both its duration and its intensity—an automatic photographic record of the amount, and the Arago-Davy conjugate thermometers for the intensity. Maximum registering thermometers have also been used for the solar intensity. Considerable trouble has been had with these, as the range of those in the market is not sufficient to withstand the great radiation here. This report is prepared too early to present the chart of the year's sunshine, which will later appear in press bulletin form.

The year 1900, whose record is given, while furnishing the greatest rainfall of which we have record, is in its characteristics a dry year. This is because the excess of the precipitation all comes in two—practically one—months. Over one-half of the rainfall fell in April, all the other months except September being below the normal. This gives the year the characteristics of the dry seasons—an increased temperature and greater range, with more sunshine. The highest temperature of the year was but 94.4 degrees, with a minimum of 23 degrees below zero. The wind was much less than usual, being but 55,000 miles during the year, while the average is over 66,000 miles. It is interesting to compare the features of April, the extremely rainy month, with the others. Its average daily range was but 23 degrees, a deficit of 6.5 degrees; while the average range in August was 37 degrees, an excess of 3.5 degrees. The other dry months show a daily range greater than the normal.

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EXPLANATION OF THE TABLES.

The tables show the daily observations at the main station at Fort Collins, with summaries of the observations by months for Fort Collins, the Arkansas Valley substation at Rocky Ford, the Plains substation at Cheyenne Wells, and at several volunteer stations, with other observations of soil temperatures, evaporation, etc., at Fort Collins.

In the detailed tables, under dry bulb and wet bulb, are given the observations taken to determine the amount of moisture in the air. The dry bulb temperature is that of an ordinary thermometer properly exposed, and the wet bulb is an exactly similar thermometer moistened with pure water. This is sometimes called the temperature of evaporation, because it shows the cooling due to the evaporation of the film of water over the thermometer. Actually, the two thermometers are swung in the open air. It is found that with the best of instrument shelters there is a noticeable difference between the readings inside and outside.

The dew point and relative humidity are found from the observations of the dry and wet bulb. The temperature of dew point shows the temperature at which, if the air is cooled down, dew (or frost) would begin to be deposited. The relative humidity is given in per cent., and shows the per cent. the actual amount of moisture present is to the amount which the atmosphere could hold.

The daily mean dew point and relative humidity is the mean of the two observations at 7 a. m. and 7 p. m.

The maximum and minimum temperatures are determined by the ordinary type of recording thermometers, both being read at 7. a. m. and 7 p. m. Usually the highest temperature occurs during the daylight hours, but in exceptional cases during the winter it may occur outside of these times. In such cases the time of maximum temperature is found by the sheets from the thermograph, and the highest and lowest temperatures of the twenty-four hours are recorded in these columns. The mean temperature for the day is the mean of the highest and the lowest temperatures. The range is the difference between the maximum and the minimum temperatures of the day.

The readings of the barometer are taken from an ordinary mercurial thermometer in the office. The readings as

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given are corrected for temperature and instrumental error, but not for elevation of the basin, which is 4,994 feet above sea level.

The terrestrial radiation is determined by a minimum thermometer placed in the instrument plat, with its bulb a few inches above sod, and the column headed "Radiation" is the difference between the reading of this instrument and the minimum thermometer. It will be noted that it is less than the minimum thermometer, and that the radiation is often considerable. The precipitation is measured in inches. The movement of the wind is determined by means of anemometers placed on the tower of the college building, about sixty feet above the ground, and is measured in miles.

The actinometer records are those taken from a set of Arago-Davy conjugate thermometers, the one being a black bulb and the other a bright bulb thermometer, enclosed in an envelop of glass, and with the bulbs freely exposed to the sky. The reading is taken at noon. As other duties often interfere with presence at the office at this hour, there are numerous blanks. The radiation is expressed in calories, as determined from a table which was made by comparing the observations throughout a cloudless day at short intervals. It thus includes the constant of these particular instruments, and is thus given in absolute measurements.

The soil temperatures are taken by means of long thermometers, with bulbs set in the ground at the depths indicated. Set "A" is in an irrigated tract of ground, with a small lateral running near the side of the enclosure. The surface is covered with grass. The readings are taken at 7 a. m. and 7 p. m. Set "C" is located in a tract of unirrigated ground above ditches, and as it is some distance from the office the readings are taken weekly at 4 p. m. The extreme temperature is given in the next table, which shows the highest temperatures as found by the readings at 7 a. m. and 7 p. m. In some cases the maximum readings have been disturbed by irrigation water, which has brought the maximum temperature at a different time than would be the case under ordinary conditions.

The evaporation is measured in a tank three feet cube placed flush with the ground. The readings of the height of the surface of the water are made by means of a hook gage, which permits the measurement to be taken to the one-thousandth part of a foot. From April to September readings

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are taken twice per day, at 7 a. m. and 7 p. m. From September until the formation of ice, late in November, the readings are taken at 7 a. m. only. In the winter season, after ice forms, readings are taken monthly. The ice is broken until it is free from the sides of the tank, then the level of the water surface is measured. Sometimes ice forms to a considerable thickness, and the separation of the ice from the sides of the tank has led to punctures of the sides.

A set of maximum and minimum thermometers are kept in the surface of the water during the summer season. An anemometer is also placed close to the ground to record the wind movement. The average temperature of the tank is less than that of water freely exposed to the air during the summer season, so that the evaporation is less than that from lakes under ordinary conditions. Tanks have been sent at different times to high altitudes, but the records have so far been incomplete and unsatisfactory. It is expected to take more in the years to come.

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TABLE I.

METEOROLOGICAL RECORD FOR JANUARY, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	13.7	13.3	12.2	93.9	20.2	19.0	16.3	85.1	14.2
2	9.2	9.0	8.4	96.5	27.0	24.1	18.6	70.3	13.5
3	27.8	25.3	20.9	74.8	25.6	23.0	18.0	72.2	19.5
4	27.8	27.0	25.8	91.9	24.0	23 0	21.1	88.7	23.4
5	15.8	15.0	12.8	88.6	22.2	21.0	18.6	85.9	15.7
6	14.1	13.2	10.5	86.5	29.2	24.6	15.6	56.2	13.1
7	13.0	12.7	11.8	95.3	29.0	24.0	13.7	52.2	12.7
8	13.2	12.3	9.5	86.1	37.3	29.0	13.6	37.2	11.6
9	23.8	22.2	19.1	81.8	29.2	25.1	17.4	60.9	18.2
10	17.8	16.8	14.3	86.6	35.9	27.0	8.0	30.6	11.2
11	12.3	12.1	11.5	96.8	36.2	28.0	11.9	36.2	11.7
12	20.1	18.3	14.1	77.5	24.0	21.3	15.7	69.8	14.9
13	49.0	38.0	23.4	36.7	52.0	39.0	21.5	30.3	22.4
14	28.8	25.8	20.5	70.8	42.3	33.9	21.6	43.4	21.1
15	32.3	31.8	31.1	95.5	31.0	31.0	31.0	100.0	31.0
16	29.3	28.9	28.3	96.0	28.8	28.8	28.8	100.0	28.6
17	33.5	28.0	18.5	53.2	30.8	26.9	20.1	64.2	19.3
18	17.0	16 2	14.1	89.0	29.2	25.9	20.0	68.3	17.0
19	18.2	17.5	15.9	90.7	33.6	27.9	17.9	51.7	16.9
20	23.3	21.8	18.9	82.7	33.5	29.3	22.7	64.1	20.8
21	18.0	16.8	13.8	84.2	23.0	20.8	16.3	74.6	15.1
22	18.0	16.8	13.8	84.2	33.0	25.1	7.3	33.3	10.5
23	16.2	15.5	13.7	90.2	26.2	24.2	20.5	78.8	17.1
24	34.0	26.8	12.5	40.5	26.3	22.8	15.8	63.8	14.2
25	9.2	8.6	6.6	89.4	22.3	19.0	11.1	61.4	8.8
26	13.0	11.0	4.6	69.3	21.0	18.8	13.8	73.2	9.2
27	16.2	14.0	7.8	69.4	16.6	16.2	15.2	94.5	11.5
28	−5.0	−5.2	−6.0	93.8	6.8	6.2	4.0	88.5	−1.0
29	35.8	28.8	16.6	44.5	23.8	22.8	20.9	88.6	18.8
30	4.2	4.2	4.2	100.0	38.3	29.3	12.2	33.8	8.2
31	11.0	10.8	10.2	96.7	30.5	25.3	15.1	52.1	12.6
Means	19.70	17.85	14.17	81.71	28.67	24.59	16.91	64.83	15.54
Normal	15.8	13.7	------	------	24.9	20.8	------	------	10.5

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TABLE I—Continued.

METEOROLOGICAL RECORD FOR JANUARY, 1900.

	Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
						7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
	Per ct	F °	F °	F °	F °	Ins.	Ins.	Ins.	F °	F °
1	89.5	39.0	10.0	24.5	29.0	25.176	25.231	25.203	6.0	4.0
2	83.4	43.4	8.7	26.0	34.7	25.147	25.024	25.086	4.5	4.2
3	73.5	55.0	22.8	38.9	32.2	24.895	24.873	24.884	19.7	3.1
4	90.3	50.0	23.7	36.9	26.3	24 891	24.999	24.945	20.2	3.5
5	87.2	50.0	15 5	32.7	34.5	25.136	25.127	25.131	10.0	5.5
6	71.4	52.0	10.0	31.0	42.0	25.125	25.211	25.168	7.9	2 1
7	73.7	49.9	14.3	32.1	35.6	25.290	25.090	25.190	10.0	4.3
8	61.7	48.0	9.2	28.6	38.8	24.900	24.920	24.910	5.0	4.2
9	71.3	47.0	25.3	36.2	21.7	25.158	25.160	25.159	20.8	4.5
10	58.6	48.2	10.2	29.2	38.0	24.922	25.042	24.982	6.3	3.9
11	66.5	44.2	11.4	27.8	32.8	25.036	24.789	24.913	6.1	5.3
12	73.7	51.0	18.7	34.8	32.3	24.904	24.932	24.918	12.9	5.8
13	33.5	60.2	24.8	42.5	35.4	24.844	24.899	24.871	20.0	4.8
14	57.1	58.0	25.2	41.6	32.8	24.845	24.839	24.842	19.9	5.3
15	97.7	34.0	30.6	32.3	3.4	25.034	25.060	25.047	26.8	3.8
16	98.0	35.2	29.0	32.1	6.2	25.011	24.980	24.996	28.2	0.8
17	58.7	44.6	26.7	35.7	17.9	25.063	25.235	25.149	24.8	1.9
18	78.7	50.2	13.7	31.9	36.5	25.263	25.184	25.223	10.0	3.7
19	71.2	63.0	18.0	40.5	45.0	25.068	24.953	25.011	14.0	4.0
20	73.4	48.3	20.0	34.2	28.3	25.125	24.985	25.055	16.7	3.3
21	79.4	51.5	13.1	32.3	38.4	24.992	25.009	25.000	8.0	5.1
22	58.7	59.5	15.0	37.2	44.5	25.001	25.110	25.056	11.5	3.5
23	84.5	55.2	14.6	34.9	40.6	25.018	24.732	24.875	10.7	3.9
24	52.2	41.6	28.3	35.0	13.3	24.874	25.119	24.996	21.7	6.6
25	75.4	40.0	5.0	22.5	35.0	25.176	25.120	25.148	2.0	3.0
26	71.2	40.4	9.0	24.7	31.4	25.020	24.902	24.961	4.1	4.9
27	82.0	26.8	10.1	18.4	16.7	24.963	25.039	25.001	6.3	3.8
28	91.1	17.5	6.0	5.8	23.5	25.177	24.931	25.054	—12.0	6.0
29	66.6	48.9	—2.4	23.2	51.3	24.818	24.933	24.876	—4.9	2.5
30	66.9	46.0	6.0	26.0	40.0	24.872	24.928	24.900	1.0	5.0
31	74.4	47.8	11.4	29.6	36.4	25.053	25.051	25.052	8.2	3.2
Means	73.27	46.66	15.22	30.94	31.44	25.026	25.013	25.019	11.17	4.05
Normal	71.2	40.5	11.0	25.8	27.3	.....	.....	24.917	.....	5.2

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TABLE I—Concluded.

METEOROLOGICAL RECORD FOR JANUARY, 1900.

Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
		Ins.	Ins.			Miles	C°	C°	C°	Cal.	
.....	.....	.....	.....	NW	S	139.0	31.0	12.0	19.0	11.74	F
.....	.....	.....	.....	N	NW	66.7	32.9	14.6	18.3	11.50	F
.....	.....	.....	.....	W	W	102.4	36.6	19.7	16.9	10.99	.....
.....	.....	.....	.....	N	N	84.4	16.1	9.1	7.0	4.04	.....
.....	.....	.....	.....	NW	W	111.9	40.6	21.3	19.3	12.76	F
.....	.....	.....	.....	E	NW	102.5	28.8	15.6	13.2	8.20	F
.....	.....	.....	.....	0	N	106.3	.....	.....	.....	.....	L, F
.....	.....	.....	.....	NW	NE	160.2	35.0	17.7	17.3	11.09	F
.....	.....	.....	.....	E	SW	160.8	35.8	17.9	17.9	11.52	.....
.....	.....	.....	.....	N	N	208.3	8.1	2.0	6.1	3.32	F
.....	.....	.....	.....	S	E	165.5	37.6	16.3	21.3	13.73	F
.....	.....	.....	.....	W	W	156.1	34.5	17.2	17.3	11.05	.....
.....	.....	.....	.....	SW	W	184.0	30.0	19.2	10.8	6.83	.....
.....	.....	.....	.....	E	SE	112.8	.....	.....	.....	.....	.....
6.50 A	8.00 P	.10	.....	0	SE	83.0	8.6	3.1	5.5	3.01	.....
.....	.....	.03	1.5	N	SE	103.0	12.8	4.5	8.3	4.64	Sn
.....	.....	.....	.....	NW	N	211.9	36.3	12.3	24.0	15.16	.....
.....	.....	.....	.....	NW	W	103.2	30.8	14.2	16.6	10.33	F
.....	.....	.....	.....	NW	SW	128.4	42.8	25.3	17.5	11.90	F
.....	.....	.....	.....	W	W	149.9	32.0	15.6	16.4	10.31	F
.....	.....	.....	.....	NW	W	148.7	.....	.....	.....	.....	F
.....	.....	.....	.....	E	E	84.4	40.0	21.8	18.2	12.09	F
.....	.....	.....	.....	SE	W	256.8	37.6	17.7	19.9	12.89	.....
.....	.....	.....	.....	N	NW	385.5	35.2	15.7	19.5	12.42	.....
.....	.....	.....	.....	N	E	124.5	32.9	12.8	20.1	12.55	F
.....	.....	.....	.....	NW	W	112.0	32.8	13.2	19.6	12.25	L, F
6.30 P	nt	T	.....	NE	E	160.5	.....	.....	.....	.....	.....
.....	.....	.06	.9	S	NW	227.1	.....	.....	.....	.....	Sn
6.00 P	7.15 P	.04	.7	NW	N	484.4	38.8	19.7	19.1	12.52	.....
.....	.....	.....	.....	N	NW	213.3	30.6	12.1	18.5	11.42	Sn
.....	.....	.....	.....	SW	W	137.9	34.5	16.0	18.5	11.76	F
.....	.....	0.25	3.1	....	....	160.5	31.26	14 87	16 39	10.39	.....
.....	.....	0.60	.....	....	....	192.0	.....	.....	.....	.....	.....

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TABLE II.

METEOROLOGICAL RECORD FOR FEBRUARY, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	12.2	11.5	9.3	88.9	29.8	24.6	14.1	51.3	11.7
2	12.8	12.2	10.5	90.6	31.7	26.0	15.0	49.3	12.7
3	24.0	20.9	14.2	65.4	35.8	27.8	12.1	37.1	13.2
4	17.2	15.8	12.1	81.0	34.6	29.2	20.4	55.4	16.2
5	21.2	20.0	17.5	85.5	30.9	24.1	8.8	38.8	13.2
6	21.1	18.0	10.1	62.4	47.0	32.0	−1.9	12.9	4.1
7	13.1	11.8	7.8	80.0	9.6	8.0	2.0	72.4	4.9
8	−7.2	−7.2	−7.2	100.0	18.8	14.2	−1.2	41.1	−4.2
9	16.7	14.0	6.1	63.0	29.0	26.1	21.0	71.8	13.5
10	9.8	9.2	7.3	89.6	25.0	23.0	19.2	78.1	13.3
11	48.9	35.3	12.6	23.1	24.0	24.0	24.0	100.0	18.3
12	13.0	13.0	13.0	100.0	−4.8	−4.8	−4.8	100.0	4.1
13	7.4	7.0	5.5	92.5	6.8	6.8	6.8	100.0	6.1
14	0.8	0.8	0.8	100.0	1.0	1.0	1.0	100.0	0.9
15	−16.8	−16.8	−16.8	100.0	−1.2	−1.2	−1.2	100.0	−9.0
16	−21.7	−21.7	−21.7	100.0	8.3	7.2	3.1	80.1	−9.3
17	−18.0	−18.0	−18.0	100.0	4.0	3.2	−0.1	83.0	−8.9
18	15.2	13.6	9.2	76.9	26.1	23.6	18.9	73.6	14.0
19	21.2	20.0	17.5	85.5	25.8	25.0	23.7	91.4	20 6
20	20.8	20.4	19.6	95.1	37.8	30.2	17.3	42.9	18.5
21	25.9	23.2	18.0	71.4	29.8	26.8	21.6	71.6	19.8
22	20.8	20.3	19.3	93.9	32.8	29.8	25.3	73.9	22.3
23	28.2	24.0	15.7	59.0	29.0	25.1	17.8	62.5	16.7
24	20.8	20.2	19.0	92.7	37.0	32.0	24.9	61.3	22.0
25	44.2	34.8	21.1	39.6	31.2	28.0	22.8	70.9	21.9
26	29.7	29.7	29.7	100.0	31.0	31.0	31.0	100.0	30.4
27	30.8	27.2	21.1	66.8	20.9	19.9	17.7	87.8	19.4
28	14.8	14.8	14.8	100.0	33.8	30.2	25.0	69.4	19.9
Means	15 25	13.36	9.57	82.25	23.62	20.46	13.72	70.59	11.65
Normal	15.6	13.7	------	------	24.8	20.9	------	------	11.6

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TABLE II—Continued.

METEOROLOGICAL RECORD FOR FEBRUARY, 1900.

Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
					7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
Perct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
70.1	48.2	10.7	29.4	37.5	24.988	24.982	24.985	7.4	3.3
69.9	46.8	14.0	30.4	32.8	24.974	24.789	24.881	10.0	4.0
51.3	48.0	29.0	38.5	19.0	24.711	24.844	24.778	20.0	9.0
68.2	46.6	13.7	30.2	32.9	24.841	24.759	24.800	8.8	4.9
62.1	44.3	15.4	29.8	28.9	24.765	24.733	24.749	11.9	3.5
37.7	56.1	15.0	35.6	41.1	24.627	24.398	24.512	10.4	4.6
76.2	15.0	8.7	11.8	6.3	24.664	24.786	24.725	8.6	0.1
70.5	33.1	−6.8	13.2	39.9	24.849	24.766	24.808	−10.6	3.8
67.4	37.2	11.6	24.4	25.6	24.834	24.979	24.906	8.0	3.6
83.9	49.0	7.0	28.0	42.0	25.068	24.927	24.998	3.1	3.9
61.5	58.0	23.0	40.5	35.0	24.575	24.700	24.637	19.6	3.4
100.0	23.8	−2.0	10.9	25.8	24.894	24.888	24.891	−9.0	7.0
96.3	25.1	−7.0	9.0	32.1	24.779	24.816	24.798	−12.2	5.2
100.0	6.0	0.0	3.0	6.0	24.889	24.979	24.934	−2.3	2.3
100.0	5.9	−17.2	−5.5	23.1	24.908	24.984	24.946	−19.2	2.0
90.0	23.8	−23.4	0.2	47.2	25.127	25 228	25.177	−23.7	5.3
91.5	26.0	−18.0	4.0	44.0	25.299	25.185	25.242	−22.8	4.8
75.3	41.2	4.6	22.9	36.6	25.003	24.868	24.936	0.0	4.6
88.4	39.2	17.2	28.2	22.0	24.855	24.662	24.758	13.7	3.5
69.0	44.1	18.0	31.0	26.1	24.749	24.860	24.805	12.8	5.2
71.5	40.2	26.3	33.3	13.9	25.010	24.997	25.003	23.0	3.3
83.9	49.6	22.0	35.8	27.6	24.807	24.886	24.847	18.7	3.3
60.8	39.7	28.4	34.0	11.3	25.054	25.058	25.056	24.6	3.8
77.0	47.9	19.0	33.5	28.9	24.984	24.904	24.944	17.0	2.0
55.2	52.8	31.3	42.0	21.5	24.817	24.998	24.907	29.3	2.0
100.0	34.1	29.0	31.6	5.1	24.914	24.848	24.881	27.2	1.8
77.3	35.8	19.6	27.7	16.2	24.991	25.175	25.083	14.0	5.6
84.7	40.1	10.3	25.2	29.8	25.088	24.894	24.991	8.1	2.2
76.42	37.77	10.69	24.23	27.08	24.895	24.889	24.892	6.84	3.86
72.6	40.3	11.8	24.9	25.0	.....	.....	24.920	.....	4.7

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TABLE II—Concluded.

METEOROLOGICAL RECORD FOR FEBRUARY, 1900.

	Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
	Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
			Ins	Ins			Miles	C°	C°	C°	Cal	
1	----	----	----	----	N	N W	124.4	37.4	18.7	18.7	12.15	F
2	----	----	----	----	N W	W	158.1	20.7	10.9	9.8	5.79	F
3	----	----	----	----	N W	W	317.3	35.5	18.0	17.5	11.26	-----
4	----	----	----	----	N W	N W	91.0	----	----	----	----	F
5	----	----	----	----	N	E	227.2	31.9	15.2	16.7	10.48	F
6	----	----	----	----	S W	W	431.0	44.6	24.2	20 4	13.92	-----
7	6.45 A	nt	.02	----	N E	N	206.8	5.5	−5.0	10.5	5.51	Sn
8	----	----	T	----	N W	N W	137.5	29.1	8.1	21.0	12.69	Sn
9	----	----	----	----	N W	W	106.8	32.4	16.2	16.2	10.23	-----
10	----	----	----	----	N W	S W	151.9	36.1	17.1	19.0	12.21	-----
11	6.00 P	nt	.04	----	W	N	463.6	----	----	----	----	-----
12	----	----	.25	4.0	W	N W	101.8	41.7	12.5	29.2	8.86	Sn
13	2.00 P	----	.19	3.¼	S W	N E	115.2	25.3	5.2	20.1	11.84	F
14	----	nt	.29	3.¾	S	S E	92.1	----	----	----	----	Sn
15	4.30 P	8.00 P	.06	.95	N W	N E	84.7	24.5	0.4	24.1	14.32	Sn
16	----	----	.03	.5	S	E	140.0	39.3	6.8	32.5	20.36	Sn
17	----	----	----	----	W	W	85.4	41.9	12.8	29.1	18 83	F
18	----	----	----	----	N W	N W	119.8	----	----	----	----	-----
19	----	----	----	----	S E	W	98.5	----	----	----	----	-----
20	----	----	----	----	W	N W	133.0	50.5	22.0	28.5	19.75	F
21	----	----	----	----	S	W	179.3	42.5	18.5	24.0	15.90	-----
22	P M	----	T	----	N W	N E	296.0	22.0	11.6	10.4	6.20	-----
23	----	----	----	----	N	S E	230.4	33.2	17.0	16 2	10.29	-----
24	----	----	----	...	N	S E	391.6	36.2	15.2	21.0	13.40	F
25	----	----	----	----	N W	S W	364.8	----	----	----	----	-----
26	6.00 A	nt	.11	1.0	N E	0	162.3	8.3	5.7	2.6	1.44	Sn
27	----	----	.11	1.¼	N W	S W	230.7	44.6	18.5	26.1	17.43	Sn
28	----	----	----	----	N W	W	130.1	24.1	8.9	15.2	9.04	F
Means	----	----	1.12	15.3	----	----	199.0	32.15	12.66	19.49	11.90	-----
Normal	----	----	0.62	----	----	----	202.0	----	----	----	----	-----

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TABLE III.

METEOROLOGICAL RECORD FOR MARCH, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	33.9	29.1	21.4	59.4	32.9	30.9	28.1	82.2	24.7
2	26.9	26.1	24.8	91.7	37.0	35.2	33.0	85.7	28.9
3	30.8	29.8	28.4	90.6	44.4	37.0	27.7	52.0	28.1
4	27.0	27.0	27.0	100.0	27.0	27.0	27.0	100.0	27.0
5	23.0	23.0	23.0	100.0	35.0	26.1	6.0	29.0	14.5
6	23.1	20.9	16.4	74.7	32.0	27.0	18.1	55.5	17.2
7	25.2	23.8	21.2	84.7	38.0	31.8	22.5	53.3	21.9
8	28.0	27.0	25.4	89.8	55.7	40.2	19.0	23.7	22.2
9	38.7	31.2	19.0	44.7	43.0	36.2	27.6	54.1	23.3
10	36.0	32.0	26.4	68.1	46.2	39.7	32.5	59.2	29.4
11	33.2	30.8	27.4	79.0	45.3	36.3	24.2	43.1	25.8
12	40.2	34.1	25.9	56.4	56.2	39.2	13.0	18.1	19.5
13	33.9	31.2	27.4	77.0	44.0	35.8	24.8	46.6	26.1
14	30.0	30.0	30.0	100.0	36.9	29.8	16.8	45.3	23.4
15	21.8	21.8	21.8	100.0	28.2	28.0	27.7	96.0	24.7
16	22.1	21.3	19.7	90.4	25.7	24.0	20.9	81.7	20.3
17	17.0	17.0	17.0	100.0	39.0	31.2	18.5	43.2	17.8
18	26.9	25.7	23.7	87.5	40.9	34.1	24.7	52.3	24.2
19	34.6	31.5	27.2	74.2	40.4	33.4	23.3	50.3	25.2
20	28.2	27.2	25.6	89.9	34.0	30.0	24.0	66.3	24.8
21	30.0	27.2	22.6	73.5	40.0	32.0	19.4	43.2	21.0
22	31.3	29.0	25.6	78.8	43.2	34.1	20.6	40.1	23.1
23	30.7	28.9	20.3	64.9	49.4	40.0	29.0	45.4	24.7
24	31.1	31.1	31.1	100.0	37.0	32.8	27.1	67.3	29.1
25	31.7	30.2	28.1	86.3	50.9	38.9	23.2	33.9	25.6
26	32.8	30.0	25.9	75.4	48.7	41.9	34.9	59.3	30.4
27	38.5	35.0	30.6	73.7	31.0	30.2	29.0	92.5	29.8
28	13.2	12.7	11.3	92.3	34.1	32.0	29.2	82.0	20.3
29	26.2	25.2	23.5	89.3	32.7	27.9	19.7	58.1	21.6
30	23.3	23.1	22.7	97.7	38.9	35.0	30.1	71.1	26.4
31	30.8	30.0	28.8	92.5	41.0	36.0	29.8	64.8	29.3
Means	29.04	27.13	24.17	83.31	39.64	33.35	24.24	57.98	24.20
Normal	26.9	24.1	.....	.....	35.0	29.1	.....	.....	19.8

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TABLE III—Continued.

METEOROLOGICAL RECORD FOR MARCH, 1900.

	Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
						7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
	Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
1	70.8	51.8	30.0	40.9	21.8	25.028	25.092	25.060	27.2	2.8
2	88.7	50.7	26.7	38.7	24.0	25.047	25.031	25.039	24.7	2.0
3	71.3	58.2	29.2	43.7	29.0	24.890	24.868	24.879	27.3	1.9
4	100.0	47.6	25.7	36.6	21.9	24.968	24.882	24.925	25.6	0.1
5	64.5	42.4	21.7	32.1	20.7	24.648	24.776	24.712	22.2	−0.5
6	65.1	41.6	21.2	31.4	20.4	24.937	24.977	24.957	18.0	3.2
7	69.0	55.4	20.8	38.1	34.6	25.028	24.984	25.006	18.0	2.8
8	56.7	65.2	25.8	45.5	39.4	24.933	24.978	24.955	23.2	2.6
9	49.4	61.0	33.3	47.1	27.7	25.267	25.251	25.259	27.8	5.5
10	63.7	76.9	33.4	55.2	43.5	25.249	25.148	25.199	28.7	4.7
11	61.0	75.2	29.7	52.4	45.5	25.193	25.108	25.150	25.2	4.5
12	37.3	73.0	27.0	50.0	46.0	25.057	25.082	25.070	23.3	3.7
13	61.8	60.9	27.6	44.3	33.3	25.091	25.224	25.157	22.2	5.4
14	72.6	43.2	25.2	34.2	18.0	25.264	25.072	25.168	21.3	3.9
15	99.0	29.9	21.7	25.8	8.2	25.030	24.920	24.975	20.7	1.0
16	86.1	30.0	21.0	25.5	9.0	24.900	24.936	24.918	20.4	0.6
17	71.6	47.7	16.0	31.8	31.7	24.936	24.834	24.885	15.0	1.0
18	69.9	59.8	19.7	39.8	40.1	24.800	24.732	24.766	17.2	2.5
19	62.2	56.0	24.0	40.0	32.0	24.793	24.897	24.845	20.8	3.2
20	78.1	46.3	25.2	35.7	21.1	25.109	25.144	25.157	22.9	2.3
21	58.4	58.1	19.8	39.0	38.3	25.136	24.992	25.064	16.8	3.0
22	59.4	62.7	20.7	41.7	42.0	24.967	24.800	24.883	16.6	4.1
23	55.2	58.5	27.0	42.7	31.5	24.871	24.826	24.849	22.1	4.9
24	83.6	61.8	29.0	45.4	32.8	24.785	24.873	24.829	24.7	4.3
25	60.1	60.0	22.6	41.3	37.4	24.869	24.794	24.831	18.7	3.9
26	67.4	67.2	26.4	46.8	40.8	24.704	24.677	24.691	24.3	2.1
27	83.1	39.2	30.2	34.7	9.0	24.647	24.797	24.722	29.9	1.2
28	87.1	38.7	9.7	24.2	29.0	25.029	25.060	25.044	4.9	4.8
29	73.7	43.9	21.9	32.9	22.0	25.182	25.224	25.203	19.1	2.8
30	84.4	47.0	18.2	32.6	28.8	25.299	25.153	25.226	16.0	2.2
31	78.7	61.5	22.8	42.2	38.7	25.216	25.123	25.170	19.4	3.4
Means	70.64	53.92	24.30	39.11	29.62	24.998	24.976	24.987	21.40	2.90
Normal	66.9	49.6	21.6	34.9	27.1	.....	.....	24.901	.....	4.9

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TABLE III—Concluded.

METEOROLOGICAL RECORD FOR MARCH, 1900.

Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
		Ins.	Ins.			Miles	C°	C°	C°	Cal.	
.....	.....	.....	.....	N	S	192.6	38.5	19.8	18.7	12.25	.....
.....	.....	.....	.....	NW	NW	90.1	32.6	17.3	15.3	9.70	F
.....	.....	.....	.....	W	S	126.3	28.5	13.7	14.8	9.11	.....
.....	.....	.....	.....	SE	SE	164.0	.....	.....	.....	.....	Fog
10.40 A	.....	T	.....	E	W	283.1	2.5	—1.8	4.3	2.26	Hr F
.....	.....	.....	.....	SE	N	97.8	26.0	12.2	13.8	8.37	F
.....	.....	.....	.....	NW	NW	123.4	39.0	21.0	18.0	11.87	F
.....	.....	.....	.....	S	SW	209.5	34.5	19.9	14.6	9.42	F
.....	.....	.....	.....	W	SW	146.5	42.5	25.0	17.5	11.88	.....
.....	.....	.....	.....	S	W	124.8	48.9	32.5	16.4	11.74	.....
.....	.....	.....	.....	N	W	131.7	.....	.....	.....	.....	.....
.....	.....	.....	.....	SE	W	231.2	50.0	33.2	16.8	12.11	L F
.....	.....	.....	.....	NE	N	225.5	46.2	28.3	17.9	12.48	.....
nt	7.15 A	.22	2.6	E	NW	188.2	35.3	17.0	18.3	11.72	Sn
nt	7.20 A	.14	1.8	SE	S	231.2	9.1	2.1	7.0	3.83	Sn
11.00 A	3.00 P	.07	Melted	S	SW	116.4	.....	.....	.....	.....	.....
.....	.....	.....	.....	0	W	120.2	34.1	16.5	17.6	11.20	Hr F
.....	.....	.....	.....	0	NE	238.7	.....	.....	.....	.....	F
.....	.....	.....	.....	S	N	300.2	41.7	23.0	18.7	11.56	F
.....	.....	.....	.....	0	S	167.3	.....	.....	.....	.....	F
.....	.....	.....	.....	S	W	116.9	41.7	24.2	17.5	11.80	F
.....	.....	.....	.....	SE	W	150.1	44.5	27.3	17.2	11.87	F
.....	.....	.....	.....	NW	S	130.7	36.3	21.7	14.6	9.55	.....
3.45 P	.....	T	.....	0	N	194.7	24.2	16.8	7.4	4.53	Fog
.....	.....	.....	.....	NE	SW	133.8	.....	.....	.....	.....	F
6.50 P	nt	T	.....	0	N	176.1	34.9	24.5	10.4	6.84	.....
12 N	5.00 P	.57	3.5	N	S	127.5	.....	.....	.....	.....	Rn
.....	.....	.....	.....	0	SW	166.2	49.6	19.8	29.8	20.40	F
.....	.....	.....	.....	NW	N	141.8	24.0	10.8	13.2	7.90	F
7.50 P	10.00 P	.....	.....	SE	N	112.7	33.3	14.9	18.4	11.60	F
.....	.....	.07	.....	0	NW	121.1	40.5	23.4	17.1	11.45	F
.....	.....	1.07	.....	....	....	163.9	34.93	19.30	15.64	10.23	.....
.....	.....	0.86	.....	....	....	235.0	.....	.....	.....	.....	.....

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TABLE IV.

METEOROLOGICAL RECORD FOR APRIL, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	38.2	35.1	31.3	76.6	49.7	38.3	23.3	35.4	27.3
2	44.9	39.2	32.9	63.2	56.2	42.5	26.6	33.2	29.7
3	43 0	37.1	30.0	60.5	53.7	45.2	37.3	54.1	33.7
4	37.3	37.0	36.6	97.5	33.0	32.6	32.1	96.4	34.3
5	33.9	33.3	32.6	94.8	34.1	33.8	33.4	97.4	33.0
6	32.3	32.3	32.3	100.0	38.5	38.5	38.5	100.0	35.4
7	36.3	35.3	34.1	91.9	47.2	44.8	42.8	85.0	38.5
8	44.7	41.7	38.8	80.4	42.9	42.5	42.1	97.2	40.4
9	37.1	36.1	34.9	92.0	39.6	37.0	34.0	80.9	34.5
10	31.2	31.2	31.2	100.0	24.2	24.0	23.6	97.8	27.4
11	18.2	18.0	17.6	97.4	29.7	27.7	24.6	80.6	21.1
12	31.2	30.2	28.8	90.7	37.1	34.1	30.2	76.7	29.5
13	36.9	34.3	31.0	79.6	48.3	44.1	40.3	74.4	35.6
14	40.8	37.2	33.1	74.5	44.2	41.9	39.7	84.7	36.4
15	42.0	39.9	37.8	85.4	39.7	38.1	36.4	88.2	37.1
16	39.2	34.2	27.6	63.4	43.1	36.0	26.4	52.6	27.0
17	32.5	32.0	31.4	95.5	32.8	32.5	32.1	97.3	31.8
18	19.8	19.2	18.0	92.5	50.2	45.1	40.6	70.1	29.3
19	44.7	41.2	37.7	77.2	56.1	48.7	42.8	61.0	40.2
20	47.5	44.2	41.3	79.5	56.1	48.0	41.3	57.7	41.3
21	49.7	45.7	42.3	76.2	58.2	48.6	40.6	52.7	41.5
22	46.6	44.8	43.3	88.6	42.7	38.0	32.6	68.2	37.9
23	42.6	38.2	33.3	70.1	49.0	42.0	34.8	58.4	34.1
24	47.0	41.2	35.2	64.1	46.9	43.3	40.1	77.6	37.6
25	45.5	43.1	41.0	84.6	44.9	41.1	37.3	75.3	39.2
26	47.5	43.5	39.8	75.3	58.2	44.5	30.0	34.4	34.9
27	53.1	45.9	39.6	60.2	43.9	43.2	42.6	95.2	41.1
28	47.6	45.6	43.9	87.5	51.3	49.8	48.7	91.1	46.3
29	39.0	37.8	36.5	90.9	34.6	32.9	30.6	85.6	33.5
30	34.3	34.0	33.6	97.4	39.9	37.9	35.7	85.4	34.7
Means	39.49	36.95	34.25	82.92	44.20	39.89	35.37	74.79	34.81
Normal	41.4	36.0	------	------	48.2	38.7	------	------	28.0

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TABLE IV—Continued.

METEOROLOGICAL RECORD FOR APRIL, 1900.

Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
					7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
56.0	71.0	27.0	49.0	44.0	25.162	25.022	25.092	22.1	4.9
47.7	73.9	28.7	51.3	45.2	24.977	24.809	24.893	24.2	4.5
57.3	68.8	29.6	49.2	39.2	24.755	24.762	24.758	24.7	4.9
96.9	38 2	32.5	35.3	5.7	25.006	25.105	25.056	31.5	1.0
96.1	42.5	32.1	37.3	10.4	25.105	25.066	25.085	31.8	0.3
100.0	44.7	29.4	37.1	15.3	25.014	24.872	24.943	26.3	3.1
88.5	54.0	31.0	42.5	23.0	24.667	24.653	24.660	29.8	1.2
88.8	56.2	31.5	43.8	24.7	24.635	24.557	24.596	28.5	3.0
86.4	48.0	36.1	42.1	11.9	24.649	24.844	24.747	35.5	0.6
98.9	32.0	24.1	28.0	7.9	25.073	25.402	25.238	26.0	−1.9
89.0	37.7	5.1	21.4	32.6	25.344	25.233	25.288	−2.0	7.1
83.7	45.7	23.2	34.5	22.5	25.190	25.027	25.109	20.0	3.2
77.0	53.5	30.8	42.1	22.7	24.876	24.715	24.795	27.5	3.3
79.6	55.2	32.8	44.0	22.4	24.732	24.777	24.755	29.2	3.6
86.8	42.0	35.0	38.5	7.0	24.847	24.933	24.890	34.8	0,2
58.0	50.2	38.8	44.5	11.4	25.025	25.016	25.020	38.1	0.7
96.4	40.8	32.2	36.5	8.6	25.005	24.987	24.996	31.8	0.4
81.3	58.4	12.5	35.5	45.9	24.970	24.889	24.930	4.8	7.7
69.1	68.3	31.6	49.9	36.7	24.961	24.913	24.947	29.7	1.9
68.6	72.0	33.5	52.8	38.5	24.899	24.762	24.830	30.0	3.5
64.5	70.3	37.9	54.1	32.4	24.742	24.589	24.666	34.5	3.4
78.4	56.0	40.9	48.4	15.1	24.538	24.570	24.554	37.3	3.6
64.2	59.9	31.1	45.5	28.8	24.726	24.772	24.749	26.8	4.3
70.9	59.6	36.0	47.8	23.6	24.798	24.777	24.787	31.3	4.7
79.9	58.1	35.3	46.7	22.8	24.791	24.786	24.789	29.8	5.5
54.9	66.9	30.0	48.5	36.9	24.831	24.766	24.798	26.4	3.6
77.7	68.7	41.7	55.2	27.0	24.849	24.940	24.895	35.3	6.4
89.3	61.7	43.2	52.4	18.5	25.001	24.974	24.987	41.1	2.1
88.2	39.6	32.4	36.0	7.2	25.163	25.309	25.236	32.0	0.4
91.4	42.1	32.0	37.1	10.1	25.274	25.127	25.201	32.0	0.0
78.85	54.53	31.27	42.90	23.27	24.921	24.899	24.910	28.36	2.91
57.0	61.9	32.1	46.3	29.7	----------	----------	24.940	------	4.5

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TABLE IV—Concluded.

METEOROLOGICAL RECORD FOR APRIL, 1900.

	Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
	Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
			Ins	Ins			Mles	C°	C°	C°	Cal	
1.	....	....	....	....	N W	W	135.9	....	....	....	....	F
2.	....	....	....	....	0	W	149.5	46.7	31.8	14.9	10.55	F
3.	....	....	....	....	S W	E	588.2	....	....	....	....	.....
4.	nt	....	1.52	7.0	E	E	77.5	....	....	....	....	Rn
5.	....	7.30 A	.49	1½	0	N	92.9	48.6	21.7	26.9	18.47	Sn
6.	5.30 P	....	.23	....	N W	N	120.4	38.8	18.0	20.8	13.55	Fog
7.	....	nt	.20	....	W	W	110.5	....	....	....	....	Rn
8.	3.30 P	....	.22	....	N W	S	248.8	....	....	....	....	F
9.	11.30A	nt	.91	....	S	N	234.5	22.6	11.1	11.5	6.85	Rn
10.	nt	7.30 P	.62	6.5	N E	N	224.2	44.1	17.9	26.2	17.43	Sn
11.	....	....	....	....	W	W	108.0	....	....	....	....	.....
12.	....	....	....	....	W	S	126.4	32.8	17.2	15.6	9.90	F
13.	7.10 P	....	T	....	N E	S	110.1	37.7	17.6	20.1	13.02	F
14.	5.50 P	6.20 P	.15	....	W	N	210.3	31.0	17.8	13.2	8.34	F
15.	nt	Int. all day	.84	....	N	NNW	427.4	....	....	....	....	Rn
16.	nt	....	....	....	N	N W	255.3	29.0	13.7	15.3	9.44	.....
17.	3.00 P	8.30 A	.46	2¼	N E	N E	79.5	10.5	5.9	4 6	2.56	Sn
18.	....	nt	.13	1	W	W	78.6	....	....	....	....	Sn
19.	....	....	....	....	W	S	116.4	44.2	28.5	15.7	10.87	F
20.	....	....	....	....	S E	S	154.2	45.0	29.0	16 0	11.13	F
21.	5.50 P	....	T	....	E	N E	151.5	47.2	30.6	16.6	11.72	D
22.	Int. a	11 day	.08	....	N	N	196.7	....	....	....	....	D
23.	....	....	....	....	N	N W	102.2	29.1	18.7	10.4	6.54	F
24.	2.30 P	....	.02	....	S	N W	145.6	....	....	....	....	L F
25.	5.00 P	....	T	....	N	S E	134.7	22.5	15.2	7.3	4.42	L F
26.	....	....	....	....	N	N W	135.8	45.0	28.5	16.5	11.46	Hv F
27.	2.30 P	....	1.10	Some hail	N E	N E	239.6	46.2	29.7	16.5	11.57	.....
28.	5.35 P	5.45 P	.70	Some hail	N W	N	208.1	39.2	23.8	15.4	10.20	Rn
29.	nt	All day	2.39	....	N W	N W	131.6	....	....	....	....	Rn
30.	....	8 00 A	.50	4.5	S E	0	72.4	40.2	18.1	22.1	14.49	Sn
Means	....	....	10.56	22¾	....	....	172.2	36.86	20.78	16.08	10.66	.....
Normal	....	....	2.12	....	....	....	244.	....	....	....	....	.....

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TABLE V.

METEOROLOGICAL RECORD FOR MAY, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	Per ct.
1	33.2	33.2	33.2	100.0	48.9	44.9	41.4	75.9	37.3
2	47.1	42.3	37.7	70.1	50.4	45.3	40.9	70.2	39.3
3	48.7	45.5	42.8	80.6	57.6	48.0	39.9	51.8	41.3
4	58.2	48.7	40.9	52.7	62.8	52.0	44.0	50.4	42.5
5	53.8	49.1	45.6	73.8	58.7	46.2	34.2	39.8	39.9
6	54.2	47.1	41.2	61.4	55.3	50.2	46.4	72.2	43.8
7	59.1	49.1	40.9	51.1	59.7	47.6	36.7	42.4	38.8
8	51.7	47.5	44.2	75.9	61.2	49.9	40.8	47.1	42.5
9	53.9	47.7	42.7	65.8	68.1	55.7	47.5	48.9	45.1
10	60.2	53.0	48.1	64.3	65.7	54.0	45.9	48.9	47.0
11	62.0	51.1	42.7	49.4	63.7	52.0	44.3	49.4	43.5
12	56.0	43.8	30.8	38.6	58.9	49.0	40.9	51.4	35.8
13	55.9	44.1	31.8	40.3	64.7	47.3	29.4	26.5	30.6
14	47.6	43.9	40.6	77.2	51.8	46.8	42.7	71.3	41.7
15	52.1	47.0	42.8	70.9	57.0	47.2	38.6	50.4	40.7
16	53.0	46.9	41.8	65.9	62.9	51.1	42.0	46.4	41.9
17	57.2	46.2	36.0	45.2	45.8	43.8	42.0	87.1	39.0
18	46.0	44.0	42.2	87.2	48.9	43.9	39.3	70.0	40.7
19	47.7	44.7	42.1	81.4	50.1	47.9	46.3	86.8	44.2
20	45.7	45.7	45.7	100.0	47.3	45.8	44.6	90.6	45.2
21	50.9	48.8	47.2	87.6	55.3	51.2	48.3	77.5	47.7
22	56.2	51.0	47.2	72.0	62.7	54.9	49.9	62.9	48.6
23	55.9	46.8	38.8	52.8	61.6	53.0	47.0	58.9	42.9
24	55.6	51.9	49.4	79.6	61.0	52.4	46.3	58.6	47.8
25	62.7	55.0	50.1	63.4	66.9	53.9	44.8	44.8	47.5
26	59.8	52.0	46.5	61.4	68.3	57.1	50.2	52.6	48.3
27	59.7	52.8	48.1	65.4	69.6	53.9	42.3	37.3	45.2
28	59.2	55.7	53.6	81.7	72.1	57.1	47.4	41.6	50.5
29	67.9	54.9	45.1	45.5	66.0	54.0	45.6	48.0	45.4
30	58.9	54.3	51.4	76.2	68.7	59.8	54.9	61.4	53.1
31	59.2	56.2	54.4	84.3	67.7	52.5	40.7	37.5	47.6
Means	54.49	48.39	43.41	68.44	59.98	50.59	43.39	56.70	43.40
Normal	51.3	45.2	.....	.....	56.6	47.0	.....	.....	38.6

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TABLE V—Continued.

METEOROLOGICAL RECORD FOR MAY, 1900.

	Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
						7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
	F°	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
1	87.9	61.7	29.8	45.7	31.9	25.007	24.926	24.966	26.3	3.5
2	70.2	59.2	45.0	52.1	14.2	25.129	25.112	25.121	41.2	3.8
3	66.2	69.5	34.3	51.9	35.2	25.150	25.007	25.078	28.8	5.5
4	51.5	74.4	40.0	57.2	34.4	25.021	24.870	24.946	34.2	5.8
5	56.8	75.7	43.1	59.4	32.6	24.850	24.761	24.805	38.1	5.0
6	66.8	68.3	44.0	56.2	24.3	24.852	24.894	24.873	39.1	4.9
7	46.8	70.3	46.4	58.3	23.9	25.055	25.104	25.080	40.8	5.6
8	61.5	72.6	39.6	56.1	33.0	25.251	25.220	25.235	32.4	7.2
9	56.9	79.1	42.4	60.8	36.7	25.251	25.073	25.162	35.2	7.2
10	56.6	84.1	43.2	63.6	40.9	25.069	24.910	24.990	36.2	7.0
11	49.4	81.4	42.8	62.1	38.6	24.869	24.678	24.773	35.4	7.4
12	45.0	72.1	47.0	59.6	25.1	24.793	24.698	24.746	38.5	8.5
13	33.4	74.0	51.4	62.7	22.6	24.794	24.833	24.813	37.1	14.3
14	74.2	66.2	45.9	56.0	20.3	25.068	25.077	25.073	43.7	2.2
15	60.7	66.8	41.3	54.1	25.5	25.211	25.132	25.171	34.0	7.3
16	56.1	73.9	35.0	54.4	38.9	25.061	24.871	24.976	29.1	5.9
17	66.2	61.9	45.1	53.5	16.8	24.877	24.994	24.936	40.8	4.3
18	78.6	57.4	37.7	47.6	19.7	25.016	24.991	25.003	35.0	2.7
19	84.1	63.0	32.8	47.9	30.2	25.015	24.959	24.987	28.8	4.0
20	95.3	51.0	44.9	47.9	6.1	25.013	25.047	25.030	44.8	0.1
21	82.5	65.1	44.8	55.0	20.3	25.083	25.007	25.045	42.1	2.7
22	67.5	74.9	40.3	57.6	34.6	24.936	24.814	24.875	36.5	3.8
23	55.8	73.2	49.8	61.5	23.4	24.952	24.981	24.967	44.8	5.0
24	69.1	73.2	44.8	59.0	28.4	24.978	24.903	24.940	40.1	4.7
25	54.1	77.7	49.3	63.5	28.4	25.074	25.093	25.084	43.3	6.0
26	57.0	82.1	43.7	62.9	38.4	25.150	25.008	25.079	37.2	6.5
27	51.4	84.7	44.7	64.7	40.0	25.022	24.926	24.974	39.2	5.5
28	61.6	82.3	44.9	63.6	37.4	24.990	24.920	24.955	39.5	5.4
29	46.8	82.2	54.2	68.2	28.0	25.004	25.021	25.012	48.0	6.2
30	68.8	81.9	42.0	61.9	39.9	25.094	24.936	25.015	39.1	2.9
31	60.9	83.0	48.1	65.6	34.9	25.013	24.916	24.965	41.2	6.9
Means	62.57	72.35	43.17	57.76	29.18	25.022	24.957	24.989	37.76	5.41
Normal	60.7	69.0	40.8	54.8	28.1	------	------	24.948	------	5.9

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TABLE V—Concluded.

METEOROLOGICAL RECORD FOR MAY, 1900.

Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
		Ins.	Ins.			Miles	C°	C°	C°	Cal.	
9.00 P	.....	.....	.....	S	S	179.5	.....	.....	.....	.....	Fog
6.45 P	.....	.01	.....	N	E	120.2	27.8	19.0	8.8	5.51	Rn
.....	.....	.....	.....	S E	S W	171.6	45.9	29.8	16.1	11.28	L F
.....	.....	.....	.....	W	N W	142.2	49.5	33.2	16.3	11.73	D
.....	.....	.....	.....	N	N W	149.3	49.5	33.1	16.4	11.79	D
11,1,4 P	8.00 P	.08	.....	S W	N E	197.3	.....	.....	.....	.....	.....
.....	.....	.04	.....	N W	N	233.2	36.0	19.7	16.3	10.57	Rn
.....	.....	.....	.....	S E	S E	160.3	.....	.....	.....	.....	D
.....	.....	.....	.....	N	W	105.3	49.3	33.5	15.8	11.37	D
3.00 P	.....	T	.....	S E	N	136.7	36.5	30.5	6.0	4.06	D
.....	.....	.....	.....	W	N	214.6	54.9	38.1	16.8	12.57	D
.....	.....	.....	.....	N W	N W	252.8	48.8	31.6	17.2	12.27	.....
.....	.....	.....	.....	S E	S	170.0	.....	.....	.....	.....	.....
Int.AM	.....	.14	.....	S W	S E	107.1	21.0	13.4	7.6	4.54	.....
nt	nt	.07	.....	N	N W	96.8	.....	.....	.....	.....	Rn
.....	.....	.....	.....	S	N	159.5	48.4	32.2	16.2	11.56	L F
5.00	6.40	.08	.....	N	S W	121.1	22.2	17.4	4.8	2.92	.....
.40 P	3.00 P	.02	.....	W	W	98.6	23.8	16.7	7.1	4.34	.....
5.30 P	.....	.05	.....	N E	S	197.0	31.3	21.2	10.1	6.47	D
Int PM	9.00 A	1.21	.....	E	E	189.2	.....	.....	.....	.....	Rn
nt	nt	.02	.....	0	W	96.8	43.3	27.4	15.9	10.92	Rn
.....	.....	.....	.....	W	S	186.6	.....	.....	.....	.....	D
.....	.....	.....	.....	N W	S	158.4	46.5	30.8	15.7	11.06	.....
6.10 P	6.20 P	.03	.....	N	W	122.5	33.2	22.7	10.5	6.81	D
.....	.....	.....	.....	N	N	110.7	49.8	34.7	15.1	11.00	D
.....	.....	.....	.....	N W	S E	89.1	50.0	35.1	14.9	10.82	.....
.....	.....	.....	.....	0	W	103.3	.....	.....	.....	.....	D
.....	.....	.....	.....	S W	S	132.6	52.1	37.4	14.7	10.86	D
9 00 P	.....	T	.....	N W	S	123.5	.....	.....	.....	.....	.....
.....	.....	.....	.....	E	S	97.7	.....	.....	.....	.....	.....
.....	.....	.....	.....	N W	E	144.7	33.9	27.5	6.4	4.24	.....
.....	.....	1.75	.....	....	....	147.3	40.65	27.86	12.80	8.89	.....
.....	.....	2.74	.....	....	....	198.	.....	.....	.....	.....	.....

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TABLE VI.

METEOROLOGICAL RECORD FOR JUNE, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	55.3	48.6	43.4	64.0	61.2	56.9	54.4	78.4	48.9
2	56.9	52.9	50.3	78.6	68.7	58.1	51.8	55.0	51.0
3	60.2	56.8	54.9	82.5	61.1	55.1	51.3	70.2	53.1
4	58.2	55.1	53.2	83.5	62.7	55.2	50.4	64.2	51.8
5	59.1	54.2	51.1	74.7	65.2	55.0	48.3	54.4	49.7
6	65.2	56.5	51.2	60.5	69.9	54.8	44.1	39.7	47.7
7	69.2	52.3	38.7	33.1	67.4	55.4	47.4	48.9	43.0
8	60.7	53.7	49.1	65.4	72.6	54.7	41.5	32.6	45.3
9	64.9	56.8	51.9	62.8	64.7	51.1	40.2	40.9	46.1
10	45.1	42.0	39.0	79.9	53.1	51.2	49.9	89.1	44.4
11	57.9	53.9	51.4	78.9	61.7	54.9	50.6	66.8	51.0
12	56.9	52.7	49.9	77.5	63.2	53.2	46.2	53.9	48.1
13	61.2	56.0	52.9	74.0	64.0	57.6	53.9	69.6	53.4
14	62.9	59.0	56.9	80.8	61.3	51.0	43.1	51.4	50.0
15	60.1	54.1	50.2	69.8	69.9	58.3	51.4	52.1	50.8
16	60.9	54.1	49.7	66.5	68.8	60.0	55.2	61.9	52.4
17	65.2	51.7	41.2	41.7	66.0	57.8	53.0	63.0	47.1
18	61.9	56.1	52.6	71.5	69.0	59.2	53.6	58.2	53.1
19	62.0	56.9	53.9	74.8	71.9	60.2	53.7	53.0	53.8
20	65.6	57.1	52.0	61.5	75.7	60.3	51.4	42.8	51.7
21	73.1	62.6	57.4	57.8	76.1	64.3	58.6	54.9	58.0
22	70.8	61.9	57.4	62 5	75.1	63.0	56.9	53.3	57.2
23	68.9	61.3	57.4	66.7	73.0	61.1	54.7	52.9	56.0
24	65.8	59.2	55.6	69.5	75.6	61.1	53.1	45.7	54.4
25	72.1	59.1	51.5	48.5	74.2	61.9	55.0	52.1	53.5
26	66.3	58.2	53.6	63.5	78.1	61.9	53.0	41.9	53.3
27	73.2	63.0	58.0	58.9	75.9	65.3	60.4	58.8	59.2
28	67.1	61.1	58.0	72.6	74.4	60.1	51.9	45.5	54.9
29	68.0	59.2	54.3	61.5	74.9	57.9	47.1	37.2	50.7
30	65.9	59.5	56.0	70.4	78.0	57.0	42.2	28.1	49.1
Means	63.35	56.19	51.76	67.13	69.11	57.79	50.83	53.88	51.29
Normal	60.4	53.5	.....	.....	65.9	55.1	.....	.....	48.1

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TABLE VI—Continued.

METEOROLOGICAL RECORD FOR JUNE, 1900.

Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
					7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
71.2	66.3	52.2	59.2	14.1	25.196	25.110	25.153	48.2	4.0
66.8	77.0	46.3	61.7	30.7	25.091	24.991	25.041	40.0	6.3
76.3	77.7	45.6	66.1	32.1	25.041	25.005	25.023	39.1	6.5
73.9	71.8	51.6	61.7	20.2	25.049	25.059	25.054	47.2	4.4
64.5	79.2	43.0	61.1	36.2	25.044	24.989	25.016	36.7	6.3
50.1	86.1	46.0	66.1	40.1	24.994	24.935	24.965	40.0	6.0
41.0	89.8	55.1	72.4	34.7	25.015	25.027	25.021	42.7	12.4
49.0	85.1	46.0	65.6	39.1	24.983	24.819	24.901	39.8	6.2
51.9	84.2	52.0	68.1	32.2	24.817	24.862	24.839	43.5	8.5
84.5	61.0	45.7	53.3	15.3	25.173	25.045	25.109	42.2	3.5
72.8	75.7	41.6	58.7	34.1	25.045	25.009	25.027	35.8	5.8
65.7	80.9	40.7	60.8	40.2	25.000	25.025	25.013	32.6	8.1
71.8	74.1	49.2	61.6	24.9	25.136	25.011	25.073	41.3	7.9
66.1	76.7	51.3	64.0	25.4	24.985	24.919	24.952	47.2	4.1
61.0	82.2	43.2	62.7	39.0	25.024	24.936	24.980	38.8	4.4
64.2	87.7	43.7	65.7	44.0	24.930	24.838	24.884	38.3	5.4
52.3	80.2	53.4	66.8	26.8	24.993	25.065	25.029	44.2	9.2
64.9	83.7	48.9	66.3	34.8	25.130	25.083	25.107	43.2	5.7
63.9	85.3	53.0	69.2	32.3	25.152	25.080	25.116	46.7	6.3
52.1	91.0	50.1	70.5	40.9	25.108	25.025	25.066	43.2	6.9
56.4	92.9	58.0	75.5	34.9	25.029	25.004	25.017	48.1	9.9
57.9	89.6	56.2	72.9	33.4	25.055	25.022	25.038	48.1	8.1
59.8	87.1	57.0	72.0	30.1	25.089	24.993	25.041	51.1	5.9
57.6	89.0	55.0	72.0	34.0	25.035	24.981	25.008	49.2	5.8
50.3	90.9	58.4	74.7	32.5	25.023	24.955	24.989	49.1	9.3
52.7	94.4	57.1	75.7	37.3	24.960	24.950	24.955	48.8	8.3
58.8	89.1	54.7	71.9	34.4	24.964	24.991	24.978	47.7	7.0
59.1	94.1	55.0	74.6	39.1	25.017	24.973	24.995	50.3	4.7
49.3	87.7	56.6	72.1	31.1	25.019	24.895	24.957	51.9	4.7
49.3	92.7	54.0	73.4	38.7	24.858	24.789	24.823	50.2	3.8
60.51	83.44	50.69	67.06	33.75	25.032	24.979	25.006	44.17	6.51
61.2	79.3	48.1	63.4	31.4	----------	----------	24.975	------	6.2

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TABLE VI—Concluded.

METEOROLOGICAL RECORD FOR JUNE, 1900.

	Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
	Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
			Ins.	Ins.			Miles	C°	C°	C°	Cal.	
1	About 3.00 A	....	.08	....	N	W	110.3	....	....	....	....	Rn
2	....	....	....	....	NW	E	93.0	49.4	33 8	15.6	11.24	.....
3	1.00 P	....	T	....	NW	0	124.6	....	....	....	....	
4	....	....	....	....	E	W	169.4	28.5	21.0	7 5	4.75	.....
5	....	....	....	....	0	....	151.0	....	....	....	....	.....
6	....	....	....	....	W	....	217.7	....	....	....	....	.....
7	....	....	....	....	N	W	142.5	....	....	....	....	....
8	4.30 P	....	T	....	NW	S	144.9	....	....	....	....	.....
9	7.00 P	....	T	....	NW	N	233.2	58 2	40.6	17.6	13.53	D
10	6.45 A	....	.13	....	N	S	155.5	....	....	....	....	Rn
11	7.00 P	....	.01	....	0	S	125.3	44.5	31.0	13.5	9.45	D
12	....	....	....	....	S	SW	122.0	....	....	....	....	D
13	5.15 P	5.45 P	.51	....	SE	SW	139.1	....	....	....	....	.....
14	3.45 P	....	.01	....	NW	N	133.9	39.6	30.5	9.1	6.24	D
15	....	....	....	....	0	S	104.8	51.1	36.6	14.5	10.63	D
16	....	....	....	....	NW	0	127.7	54 0	39.1	14.9	11.15	D
17	1.15 P	....	T	....	NE	SW	115.2	....	....	....	....	.....
18	4 00 P 5.00 P	5.10 P	.07	....	0	S	141.7	....	....	....	....	.....
19	....	....	....	....	N	S	77.5	....	....	....	....	D
20	....	....	....	....	0	SW	95.0	55.5	41.5	14.0	10.63	D
21	....	....	....	....	0	S	110.9	51 7	44.1	7.6	5.75	.....
22	....	....	....	....	N	E	95.5	55.0	41 8	13.2	10.02	.....
23	....	....	....	....	NE	SE	106.0	54.0	40.1	13 9	10.44	D
24	....	....	....	....	NW	W	107.0	....	....	....	....	.....
25	4.45 P	....	T	....	NW	NW	113.4	56.0	41.7	14.3	10.59	D
26	....	....	....	....	NW	S	141.2	....	....	....	....	D
27	....	....	....	....	N	S	134.6	54.5	40.6	13.9	10.54	.....
28	....	....	.01	....	SE	S	132.7	59.3	45.1	14.2	11.09	D
29	....	....	T	....	NW	SE	93.1	30.6	25.7	4.9	3.18	D
30	....	....	T	....	0	S	175.6	....	....	....	....	D
Means	....	....	0.82	....	....	....	131.1	49.46	36.88	12.58	9.30	.....
Normal	....	....	1.57	....	....	....	159.	....	....	....	....	.....

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TABLE VII.

METEOROLOGICAL RECORD FOR JULY, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	66.0	58.8	54.8	67.1	69.0	60.0	55.1	61.2	54.9
2	64.1	56.0	51.0	62.4	73.9	64.2	59.6	61.0	55.3
3	61.1	53.1	47.6	61.3	67.7	57.0	50.4	54.0	49.0
4	67.0	58.0	52.8	60.2	65.7	59.2	55.6	69.9	54.2
5	61.0	56.5	53.8	77.4	69.8	56.3	47.5	45.2	50.7
6	60.7	51.8	45.3	57.0	81.2	55.7	35.3	19.3	40.3
7	61.7	52.0	44.9	54.2	70.9	61.8	57.2	61.8	51.0
8	60.1	52.3	46.8	61.6	73.0	58.0	48.6	42.2	47.7
9	66.2	57.7	52.7	61.8	74.2	57.9	47.6	38.9	50.2
10	64.1	55.2	49.5	59.1	73.0	64.0	59.7	63.1	54.6
11	67.8	59.6	55.1	63.8	73.9	61.1	54.2	50.2	54.6
12	66.1	57.5	52.4	61.4	74.8	62.7	56.6	53.1	54.5
13	68.0	60.0	55.7	64.7	71.1	61.0	55.7	58.2	55.7
14	71.0	61.2	56.1	59.2	71.5	62.1	57.4	60.9	56.8
15	61.4	56.2	53.1	74.0	57.2	55.1	53.9	88.5	53.5
16	56.1	54.3	53.2	90.0	65.4	57.1	52.1	62.2	52.6
17	60.0	56.8	55.0	83.5	73.4	63.3	58.4	59.3	56.7
18	64.9	54.0	46.5	51.5	70.3	60.4	55.1	58.5	50.8
19	51.0	51.0	51.0	100.0	55.0	53.1	51.9	89.3	51.5
20	50.0	49.7	49.5	98.1	66.1	56.1	49.8	55.8	49.6
21	61.9	54.9	50.5	66.0	69.8	59.0	52.6	55.0	51.6
22	66.3	58.4	53.9	64.3	69.2	58.9	53.0	56.4	53.4
23	67.6	61.6	58.6	72.8	62.9	59.0	56.9	80.8	57.8
24	63.2	59.0	56.7	79.4	63.9	59.9	57.8	80.6	57.2
25	61.4	58.7	57.3	86.3	67.9	61.1	57.6	69.5	57.5
26	62.4	60.0	58.8	87.8	70.1	60.1	54.7	58.0	56.7
27	64.2	59.7	57.4	78.3	73.3	60.0	52.5	46.1	55.0
28	59.9	53.3	48.9	66.5	66.5	58.0	53.1	62.0	51.0
29	59.9	56.0	53.7	80.0	71.0	60.7	55.3	57.4	54.5
30	63.7	58.0	54.8	72.7	74.0	59.0	50.0	42.9	52.4
31	61.9	56.8	53.8	74.7	74.2	58.1	48.0	39.6	50.9
Means	62.60	56.39	52.62	70.87	69.67	59.35	53.33	58.16	52.97
Normal	64.4	58.0	------	------	69.8	59.7	------	------	53.2

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TABLE VII—Continued.

METEOROLOGICAL RECORD FOR JULY, 1900.

	Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
						7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
	Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
1	64.1	80.2	54.0	67.1	26.2	24.796	24.802	24.799	49.5	4.5
2	61.7	86.9	54.8	70.8	32.1	24.946	24.752	24.849	49.2	5.6
3	57.7	85.0	49.3	67.2	35.7	24.905	24.858	24.881	45.7	3.6
4	65.0	73.9	55.6	64.7	18.3	24.914	24.834	24.874	51.9	3.7
5	61.3	83.9	51.0	67.5	32.9	24.814	24.838	24.826	48.1	2.9
6	38.2	90.8	50.1	70.4	40.7	24.959	24.823	24.891	43.8	6.3
7	58.0	82.2	52.6	67.4	29.6	25.133	25.124	25.129	45.2	7.4
8	51.9	82.8	49.3	66.1	33.5	25.184	24.916	25.050	43.6	5.7
9	50.3	92.0	51.4	71.7	40.6	24.965	24.922	24.943	44.4	7.0
10	61.1	91.3	50.0	70.6	41.3	25.028	24.979	25.004	44.0	6.0
11	57.0	92.4	55.0	73.7	37.4	25.051	24.998	25.024	49.1	5.9
12	57.3	92.7	56.1	74.4	36.6	24.978	24.884	24.931	49.0	7.1
13	61.4	90.0	54.9	72.5	35.1	24.915	24.842	24.879	47.3	7.6
14	60.1	92.9	56.0	74.4	36.9	24.839	24.728	24.783	49.0	7.0
15	81.2	74.1	54.9	64.5	19.2	24.942	24.949	24.946	58.3	----
16	76.1	73.0	52.1	62.6	20.9	25.098	25.097	25.097	49.9	2.2
17	71.4	90.1	46.9	68.5	43.2	25.039	24.922	24.981	42.4	4.5
18	55.0	82.0	50.9	66.4	31.1	25.020	24.948	24.984	44.9	6.0
19	94.7	59.7	51.6	55.7	8.1	25.205	25.162	25.183	49.8	1.8
20	76.9	79.1	40.2	59.6	38.9	25.154	25.044	25.099	36.0	4.2
21	60.5	87.8	46.0	66.9	41.8	25.046	24.998	25.022	41.1	4.9
22	60.4	88.1	53.4	70.8	34.7	25.075	24.904	24.990	45.9	7.5
23	76.8	78.1	58.9	68.5	19.2	25.148	25.163	25.155	51.8	7.1
24	80.0	73.5	52.3	62.9	21.2	25.181	25.182	25.182	47.7	4.6
25	77.9	77.7	50.9	64.3	26.8	25.189	25.076	25.132	47.2	3.7
26	72.9	80.5	55.0	67.7	25.5	25.044	25.010	25.027	49.3	5.7
27	63.2	89.8	54.6	72.2	35.2	24.992	24.978	24.985	50.3	4.3
28	64.2	75.7	55.5	65.6	20.2	25.189	25.145	25.167	48.8	6.7
29	68.7	86.0	48.5	67.3	37.5	25.181	25.065	25.123	43.3	5.2
30	57.8	88.7	51.8	70.2	36.9	25.186	25.146	25.166	44.2	7.6
31	57.2	92.8	50.7	71.8	42.1	25.218	25.134	25.176	41.3	9.4
Means	64.52	83.67	52.07	67.87	31.59	25.043	24.975	25.009	46.84	5.52
Normal	65.2	84.3	53.3	68.4	31.3	.....	.....	25.071	.....	5.9

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TABLE VII—Concluded.

METEOROLOGICAL RECORD FOR JULY, 1900.

Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
		Ins	Ins			Miles	C°	C°	C°	Cal	
3.00 P	.....	T	.....	N	S W	121.9	.....	.....	.....	.....	.....
.....	.....	.....	.....	W	N W	101.1	51.5	36.8	14.7	10.80	D
4.15and 7.00 P	.....	.08	.....	S	W	122.7	.....	.....	.....	.....	.....
11.00 A	.....	.08	.....	N W	S W	83.3	.....	.....	.....	.....	Rn
nt	nt	.03	.....	N	S W	222.3	39.2	31.1	8.1	5.48	Rn
.....	.....	.....	.....	0	W	190.9	52.3	38.5	13.8	10.24	.....
.....	.....	.....	.....	E	N E	98.1	.....	.....	.....	.....	.....
.....	.....	.....	.....	W	S	136.4	.....	.....	.....	.....	.....
.....	.....	.....	.....	E	N E	123.4	48.5	36.5	12.0	8.71	.....
.....	.....	.....	.....	0	E	110.0	.....	.....	.....	.....	.....
.....	.....	.....	.....	S E	W	83.2	55.0	41.2	13.8	10.45	D
.....	.....	.....	.....	S E	W	114.8	60.9	45.5	15.4	12.08	.....
.....	.....	.....	.....	0	W	108.7	42.8	35.9	6.9	4.89	.....
.....	.....	.....	.....	----	W	191.6	56.0	38.7	17.3	13.03	.....
.....	.....	.07	.....	N W	0	95.0	.....	.....	.....	.....	.....
.....	About 4.00 A	.19	.....	0	0	86.0	40.3	32.5	7.8	5.40	.....
.....	.....	.....	.....	----	0	122.2	.....	.....	.....	.....	.....
.....	.....	.....	.....	----	0	137.6	21.0	14.6	6.4	3.84	.....
.....	.....	.19	.....	----	----	50.7	.....	.....	.....	.....	.....
.....	.....	.01	.....	----	----	95.8	55.2	40.4	14.8	11.18	.....
.....	.....	.....	.....	----	----	88.1	.....	.....	.....	.....	.....
4.00 P	.....	T	.....	----	N E	123.7	.....	.....	.....	.....	.....
4.40 P	5.25 P	.43	.....	N	N	105.5	27.0	24.5	2.5	1.59	D
.....	.....	.06	.....	0	S E	89.9	.....	.....	.....	.....	D
.....	.....	.....	.....	N E	N E	83.1	47.9	33.8	14.1	10.10	D
6.45 P	.....	T	.....	N	N E	113.0	55.0	39.6	15.4	11.59	D
.....	.....	.....	.....	N	N W	119.6	56.9	41.8	15.1	9.55	D
.....	.....	.....	.....	N	W	113.2	38.7	28.2	10.5	7.11	.....
.....	.....	.....	.....	N E	N W	99.0	.....	.....	.....	.....	D
.....	.....	.....	.....	N	E	94.7	53.7	40.0	13.7	10.28	.....
.....	.....	.....	.....	N	0	108.3	.....	.....	.....	.....	D
.....	.....	1.14	.....	----	----	114.0	47.17	35.27	11.90	8.61	.....
.....	.....	1.87	.....	----	----	138.	.....	.....	.....	.....	.....

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TABLE VIII.

METEOROLOGICAL RECORD FOR AUGUST, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	62.2	53.7	47.9	59.7	74.2	64.1	59.3	59.7	53.6
2	75.0	58.8	48.9	39.9	75.2	59.0	49.2	40.0	49.0
3	71.8	60.9	55.1	55.7	72.0	58.7	50.8	47.3	53.0
4	64.7	57.7	53.7	67.3	70.0	59.2	53.1	55.1	53.4
5	66.6	61.2	58.5	75.0	65.6	60.1	57.3	74.2	57.9
6	66.1	59.9	56.6	71.4	66.2	58.7	54.5	65.9	55.5
7	64.8	56.9	52.2	63.6	75.7	58.8	48.4	38.2	50.3
8	62.0	59.0	57.4	84.9	72.8	61.0	54.6	53.1	56.0
9	64.9	57.2	52.6	64.4	68.0	55.8	47.8	48.6	50.2
10	61.8	55.1	50.9	67.3	67.8	57.5	51.3	55.9	51.1
11	61.0	53.3	48.1	62.5	67.0	55.4	47.8	50.2	48.0
12	65.2	52.3	42.6	43.9	67.7	58.0	52.3	57.8	47.4
13	58.9	50.9	45.0	59.9	68.1	58.6	53.1	58.8	49.1
14	60.8	51.2	44.0	54.1	64.2	53.7	46.4	52.5	45.2
15	62.2	55.9	52.0	69.3	67.2	54.0	44.7	44.3	48.3
16	57.6	50.2	44.6	62.0	67.3	53.0	42.3	40.3	43.5
17	53.0	46.9	41.8	65.9	72.6	55.9	44.4	36.5	43.1
18	61.1	51.9	45.2	60.0	73.0	54.3	40.1	30.5	42.6
19	61.8	56.0	52.4	71.5	67.3	56.8	50.3	54.5	51.4
20	64.2	56.3	51.5	63.3	69.0	57.9	51.2	53.4	51.3
21	61.6	57.1	54.5	77.5	63.2	57.5	54.3	72.5	54.4
22	55.1	52.9	51.5	87.6	64.2	55.2	49.4	58.8	50.5
23	57.7	53.1	50.1	75.7	62.0	46.7	31.5	31.8	40.8
24	58.1	47.1	37.2	46.0	63.1	49.2	37.2	38.3	37.2
25	56.8	50.0	44.9	64.3	63.5	52.2	43.8	48.9	44.3
26	57.2	51.1	46.7	68.0	71.8	55.8	44.8	38.1	45.8
27	60.2	50.3	42.6	52.3	64.0	56.8	52.5	66.1	47.5
28	60.8	56.1	53.3	76.3	73.0	58.0	48.6	42.2	51.0
29	57.0	52.0	48.5	73.4	69.8	59.9	54.5	58.2	51.5
30	62.3	56.8	53.6	73.1	75.3	55.7	41.4	29.8	47.5
31	57.7	52.2	48.4	71.2	65.8	56.0	49.8	56.4	49.1
Means	61.62	54.32	49.43	65.39	68.60	56.56	48.60	50.25	49.02
Normal	61.9	55.7	.....	.....	68.0	57.4	.....	.....	51.2

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TABLE VIII—Continued.

METEOROLOGICAL RECORD FOR AUGUST, 1900.

Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
					7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
59.7	94.0	48.8	71.4	45.2	25.161	25.040	25.100	39.1	9.7
39.9	93.2	62.5	77.8	30.7	25.074	24.999	25.037	52.1	10.4
51.5	90.0	53.0	71.5	37.0	25.013	24.946	24.979	46.2	6.8
61.2	87.1	52.9	70.0	34.2	24.993	24.950	24.972	46.2	6.7
74.6	87.0	56.0	71.5	31.0	25.011	24.988	24.999	48.7	7.3
68.7	83.2	54.2	68.7	29.0	25.019	24.994	25.007	48.3	5.9
50.9	91.7	47.3	69.5	44.4	25.027	24.982	25.004	41.6	5.7
69.0	88.7	54.2	71.5	34.5	25.005	24.940	24.973	48.6	5.6
56.5	89.9	50.0	69.9	39.9	24.972	24.963	24.967	44.1	5.9
61.6	86.8	49.0	67.9	37.8	24.931	24.897	24.914	43.3	5.7
56.3	88.3	46.1	67.2	42.2	25.027	24.942	24.985	39.7	6.4
50.9	89.1	46.4	67.8	42.7	25.016	25.000	25.008	38.2	8.2
59.3	85.0	47.5	66.2	37.5	25.053	24.978	25.015	38.8	8.7
53.3	85.2	45.8	65.5	39.4	25.037	24.940	24.989	39.3	6.5
56.8	84.4	49.9	67.2	34.5	25.042	24.927	24.984	44.0	5.9
51.2	87.7	42.8	65.2	44.9	25.042	24.932	24.987	36.4	6.4
51.2	86.6	44.9	65.8	41.7	24.978	24.993	24.986	40.2	4.7
45.2	87.3	48.8	68.0	38.5	24.918	24.924	24.921	43.5	5.3
63.0	87.0	51.1	69.1	35.9	25.035	25.059	25.047	44.6	6.5
58.4	86.1	55.5	70.8	30.6	25.165	25.121	25.143	48.1	7.4
75.0	84.0	50.4	67.2	33.6	25.174	25.087	25.130	47.4	3.0
73.2	82.0	46.8	64.4	35.2	25.115	24.959	25.037	43.8	3.0
53.7	77.6	45.1	61.3	32.5	24.896	24.834	24.865	41.7	3.4
42.2	71.1	49.1	60.1	22.0	24.838	24.906	24.867	44.1	5.0
56.6	80.6	41.2	60.9	39.4	24.979	24.936	24.958	36.5	4.7
53.0	85.8	43.1	64.5	42.7	24.985	24.975	24.980	38.9	4.3
59.2	83.8	47.0	65.4	36.8	25.148	25.107	25.127	41.8	5.2
59.3	89.1	49.1	69.1	40.0	25.133	24.996	25.065	44.7	4.4
65.8	90.7	52.0	71.3	38.7	25.024	24.895	24.959	45.5	6.5
51.4	90.9	53.0	72.0	37.9	24.943	24.906	24.925	46.5	6.5
63.8	86.0	50.7	68.3	35.3	24.922	24.888	24.905	44.3	6.4
57.82	86.45	49.49	67.97	36.96	25.021	24.968	24.995	43.42	6.07
63.8	84.2	51.1	67.5	33.5	.....	.....	25.082	.....	3.5

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TABLE VIII—Concluded.

METEOROLOGICAL RECORD FOR AUGUST, 1900.

	Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
	Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
			Ins.	Ins.			Miles	C°	C°	C°	Cal.	
1	....	....	....	....	NE	W	120.5	53.1	40.8	12.3	9 27	D
2	....	....	....	....	NW	N	151.8	....	....	....	....	.....
3	P	....	T	....	N	NW	153.4	....	....	....	....	.....
4	10.00P	....	.01	....	N	NW	103.3	55.0	42. 0	13.0	9.87	D
5	2.00P	....	.02	....	0	SE	95.5	....	....	....	....	D
6	....	....	....	....	0	E	91.2	33.1	27.6	5.5	3.63	.....
7	....	....	....	....	N	S	119.6	....	....	....	....	D
8	....	....	....	....	0	S	98.6	52.0	38.2	13.8	10.22	D
9	3.30P	....	T	....	E	NE	131.2	48 2	37.7	10.5	7.64	D
10	1.30P	....	T	....	S	E	103.4	58.1	42.7	15.4	11.88	D
11	....	....	....	....	NE	W	126.4	52 4	37.8	14.6	10.81	.....
12	....	....	....	....	N	E	133.9	....	....	....	....	.....
13	....	....	....	....	N	0	94.7	41.6	32 5	9.1	6 33	D
14	....	....	....	....	0	S	131.7	50.4	37.1	13 3	9.75	.....
15	....	....	....	....	N	S	97.1	54:5	39.8	14.7	11.05	D
16	....	....	....	....	SE	SW	126.9	54.6	39.6	15.0	11.27	D
17	....	....	....	....	N	N	98.7	43.5	32.8	10.7	7.51	.....
18	....	....	....	....	E	NW	101.8	49.7	38.2	11.5	8.44	.....
19	....	....	....	....	SE	S	90.2	....	....	....	....	.....
20	3.00P	....	.09	....	SE	SW	94.4	54 0	40.1	13.9	10.45	.....
21	9.00P	....	.04	....	0	S	113.4	....	....	....	....	.....
22	....	....	....	....	0	NW	101.3	46.8	36.3	10.5	7.56	Rn
23	....	....	....	....	N	NE	207.2	49.2	32.6	16.6	11.90	D
24	....	....	....	....	S	NE	100.0	....	....	....	....	.....
25	....	....	....	....	0	NW	102.4	50.0	35.4	14.6	10.61	D
26	6.40P	....	T	....	N	W	110.5	....	....	....	....	D
27	....	....	....	....	N	NW	112.9	51.6	38.7	12 9	9.56	D
28	....	....	....	....	NW	SE	94.7	....	....	....	....	D
29	....	....	....	....	S	S	108.8	55.1	40.6	14 5	11.02	.....
30	....	....	....	....	N	NW	116.0	....	....	....	....	D
31	....	....	....	....	NW	....	74.2	....	....	....	....	D
Means	....	....	0.16	....	....	....	113.1	50.15	37.39	12.76	9 41	.....
Normal	....	....	1.24	....	....	....	132.0	....	....	....	....	.....

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TABLE IX.

METEOROLOGICAL RECORD FOR SEPTEMBER, 1900.

	Temperature, Dew Point and Relative Humidity.								
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Daily Mean Dew Point
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	60.0	53.8	49.7	68.8	71.2	53.7	40.3	32.8	45.0
2	53.2	46.1	39.9	60.8	59.2	52.0	46.9	63.7	43.4
3	55.8	51.3	48.1	75.6	73.7	58.3	43.8	41.4	48.4
4	60.2	57.0	55.2	83.5	70.1	55.3	45.1	40.8	50.2
5	55.9	51.2	47.9	74.6	65.9	52.5	42.4	42.6	45.1
6	59.5	52.0	46.7	62.6	66.4	57.2	51.7	59.1	49.2
7	61.3	56.6	53.8	76.5	70.8	59.6	53.3	54.1	53.6
8	64.0	58.1	54.8	71.9	63.3	60.2	58.6	84.7	56.7
9	60.0	57.5	56.1	87.0	62.5	59.0	57.1	82.6	56.6
10	57.0	55.9	55.2	94.0	63.2	59.0	56.7	79.4	55.9
11	58.4	56.1	54.7	87.7	62.3	54.8	50.0	64.0	52.4
12	54.0	51.2	49.3	84.3	61.5	54.7	50.4	66.8	49.8
13	55.2	51.9	49.7	81.7	63.9	54.9	49.1	58.6	49.4
14	65.1	45.3	21.8	19.2	62.9	46.9	30.9	30.2	26.4
15	52.2	47.0	42.7	70.4	60.0	49.2	40.3	48.3	41.5
16	42.5	40.0	37.5	81.8	52.6	48.0	44.4	73.9	40.9
17	45.5	44.5	43.6	93.5	55.1	51.7	49.4	81.1	46.5
18	49.0	43.1	37.4	64.8	58.5	40.0	11.2	15.3	24.3
19	47.5	39.2	29.4	49.7	60.9	42.9	19.9	20.4	24.7
20	47.2	39.3	30.1	51.7	51.5	43.8	35.8	56.4	32.9
21	43.6	37.9	31.3	62.3	60.1	46.0	31.9	34.6	31.6
22	51.8	42.1	31.7	46.3	51.7	45.7	40.4	65.8	36.1
23	47.3	42.3	37.5	69.2	62.0	52.3	45.3	54.5	41.4
24	53.2	48.8	45.4	75.2	51.2	46.0	41.6	70.0	43.5
25	43.2	42.7	42.2	96.5	41.8	41.2	40.6	95.8	41.4
26	35.8	35.2	34.5	95.1	36.3	36.0	35.6	97.5	35.0
27	36.7	36.2	35.6	96.0	38.9	36.8	35.5	84.7	35.6
28	34.8	34.3	33.7	95.8	47.2	42.8	38.6	72.7	36.1
29	38.8	37.1	35.1	87.2	52.9	46.0	40.0	61.7	37.6
30	40.5	38.2	35.7	83.5	49.5	45.9	42.9	78.4	39.3
Means	50.97	46.40	42.21	74.91	58.24	49.75	42.49	60.40	42.35
Normal	51.8	46.1	.....	.....	59.6	49.2	.....	.....	41.3

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TABLE IX—Continued.

METEOROLOGICAL RECORD FOR SEPTEMBER, 1900.

	Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
						7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
	Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
1	50.8	87.2	50.0	68.6	37.2	24.928	24.964	24.946	44.2	5.8
2	62.2	72.8	45.7	59.2	27.1	25.278	25.158	25.218	38.1	7.6
3	58.5	85.3	50.2	67.8	35.1	25.123	24.959	25.041	45.1	5.1
4	62.2	83.6	51.7	67.6	31.9	24.991	24.949	24.970	45.2	6.5
5	58.6	84.7	45.0	64.9	39.7	25.173	25.140	25.156	40.3	4.7
6	60.8	80.9	47.0	63.9	33.9	25.227	25.101	25.164	40.5	6.5
7	65.3	87.2	52.6	69.9	34.6	25.084	25.049	25.067	46.1	6.5
8	78.3	88.2	53.5	70.9	34.7	25.068	25.033	25.050	46.8	6.7
9	84.8	81.4	55.0	68.2	26.4	25.089	24.954	25.022	53.5	1.5
10	86.7	77.4	54.0	65.7	23.4	25.005	24.978	24.991	46.8	7.2
11	75.9	73.7	51.2	62.4	22.5	25.126	25.094	25.110	46.2	5.0
12	75.5	81.7	47.0	64.4	34.7	25.110	24.995	25.053	41.5	5.5
13	70.2	84.5	45.0	64.7	39.5	25.002	24.733	24.867	38.2	6.8
14	24.7	82.0	55.7	68.9	26.3	24.862	24.923	24.893	42.3	13.4
15	59.3	73.0	43.0	58.0	30.0	25.181	25.124	25.152	35.2	7.8
16	77.9	61.0	42.1	51.5	18.9	25.245	25.134	25.190	42.2	-0.1
17	87.3	70.0	40.5	55.3	29.5	25.065	24.873	24.969	35.0	5.5
18	40.0	81.0	40.1	60.5	40.9	24.980	24.969	24.974	30.2	9.9
19	35.1	70.1	36.5	53.3	33.6	25.107	25.022	25.065	29.0	7.5
20	54.0	70.9	34.7	52.8	36.2	25.057	25.024	25.040	28.7	6.0
21	48.5	70.0	34.1	52.1	35.9	25.057	24.986	25.022	27.2	6.9
22	56.0	70.7	35.2	52.9	35.5	25.161	25.020	25.090	27.9	7.3
23	61.9	81.9	35.6	58.8	46.3	24.817	24.469	24.643	29.9	5.7
24	72.6	67.8	47.0	57.4	20.8	24.490	24.596	24.543	40.6	6.4
25	96.1	48.8	41.4	45.1	7.4	24.892	25.100	24.996	37.8	3.6
26	96.3	41.9	34.1	38.0	7.8	25.295	25.285	24.290	32.2	1.9
27	90.4	47.7	33.0	40.3	14.7	25.253	25.148	25.201	32.2	0.8
28	84.2	62.8	29.7	46.3	33.1	25.157	25.217	25.187	35.3	4.4
29	74.5	73.6	32.6	53.1	41.0	25.180	25.048	25.114	27.9	4.7
30	80.9	74.0	34.0	54.0	40.0	25.090	24.939	25.014	28.0	6.0
Means	67.65	73.86	43.24	58.55	30.62	25.070	24.999	25.035	37.47	5.77
Normal	60.7	77.9	42.6	59.7	35.5	.....	.....	25.056	.....	5.8

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TABLE IX—Concluded.

METEOROLOGICAL RECORD FOR SEPTEMBER, 1900.

Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
		Ins.	Ins.			Miles	C°	C°	C°	Cal.	
.....	.....	T	.....	E	W	183.6	56.4	40.8	15.6	11.96	D
.....	.....	.....	.....	S	SE	116.1	.....	.....	.....	.....	.....
.....	.....	.....	.....	NW	SE	122.9	52.5	37.0	15.5	11.45	D
.....	.....	.01	.....	NW	NW	126.8	.....	.....	.....	.....	.....
9.00 P	.....	T	.....	NW	....	134.7	.....	.....	.....	.....	Rn
.....	.....	.....	.....	....	....	120.0	.....	.....	.....	.....	.....
.....	.....	T	.....	....	....	133.1	.....	.....	.....	.....	.....
.....	.....	.25	.....	N	....	94.1	.....	.....	.....	.....	.....
.....	.....	.22	.....	N	....	105.4	.....	.....	.....	.....	.....
5.15 P	8.00 P	.16	.....	N	N	91.7	.....	.....	.....	.....	.....
.....	.....	T	.....	SE	S	111.1	.....	.....	.....	.....	.....
.....	.....	.....	.....	S	SW	95.5	54.2	37.4	16.8	12.51	H D
.....	.....	.....	.....	E	S	221.9	51.6	35.4	16.2	11.85	D
.....	.....	.....	.....	W	NW	174.6	Taken	out	.....	.....	.....
.....	.....	.....	.....		NE	130.1	Taken	out	.....	.....	.....
.....	.....	•	.....	N	NE	85.3	Taken	out	.....	.....	.....
.....	.....	.....	.....	E	NE	149.5	Taken	out	.....	.....	.....
.....	.....	.....	.....	SE	W	253.4	Taken	out	.....	.....	.....
.....	.....	.....	.....	S	W	153.5	.....	.....	.....	.....	L F
.....	.....	.....	.....	NW	NW	103.6	.....	.....	.....	.....	L F
.....	.....	.....	.....	N	N	99.4	.....	.....	.....	.....	L F
.....	.....	.....	.....	N	N	128.6	.....	.....	.....	.....	L F
4.00 P	.....	T	.....	NW	N	101.9	.....	.....	.....	.....	F
11.00 P	Int. P M	.11	.....	E	N	122.2	.....	.....	.....	.....	Rn
.....	.....	.35	.....	SE	E	103.8	.....	.....	.....	.....	Rn
.....	.....	.54	.....	E	E	72.5	.....	.....	.....	.....	Rn
.....	Abt 8. A	.28	.....	SE	N	72.0	.....	.....	.....	.....	Rn
.....	.....	.....	.....	NW	N	107.7	.....	.....	.....	.....	HvF
.....	.....	.....	.....	0	N	89.6	.....	.....	.....	.....	F
.....	.....	.....	.....	SW	NE	98.9	.....	.....	.....	.....	.....
.....	.....	1.92	.....	.....	....	123.4	53.68	37.65	16.03	11.94	.....
.....	.....	.85	.....	....	....	139.	.....	.....	.....	.....	.....

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TABLE X.

METEOROLOGICAL RECORD FOR OCTOBER, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F °	F °	F °	Per ct.	F °	F °	F °	Per ct.	F °
1	43.1	39.8	36.4	77.7	60.2	46.0	31.8	34.3	34.1
2	42.4	40.0	37.5	83.5	55.8	45.0	34.4	44.8	35.9
3	42.0	40.1	38.1	86.8	54.0	45.3	37.2	53.3	37.7
4	61.8	45.7	28.6	28.6	57.3	46.0	35.3	44.0	31.9
5	43.2	38.8	33.9	70.4	58.1	45.8	33.9	40.1	33.9
6	48.0	37.1	22.1	35.9	45.0	33.2	12.7	26.8	17.4
7	30.8	29.2	26.9	85.0	37.7	32.8	26.0	62.7	26.5
8	31.8	28.8	24.1	73.1	43.0	36.6	28.7	57.2	26.4
9	31.2	29.0	25.7	79.6	38.9	33.1	25.0	57.2	25.3
10	32.9	29.1	23.2	66.9	42.2	35.2	25.9	52.3	24.6
11	37.2	32.0	24.5	59.9	46.9	37.9	32.1	56.7	28.3
12	34.7	30.8	25.1	67.7	53.2	44.0	34.9	50.2	30.0
13	40.2	36.6	32.4	74.1	59.2	47.3	36.5	42.9	34.4
14	49.8	44.2	39.0	67.1	61.6	48.8	37.7	41.2	38.4
15	56.6	48.1	41.1	56.1	53.2	48.2	44.3	71.9	42.7
16	40.4	39.9	39.4	96.3	43.8	42.0	40.3	87.9	39.8
17	35.5	35.0	34.4	95.8	49.1	44.0	39.3	69.6	36.9
18	39.2	37.5	35.6	87.3	46.1	41.2	36.3	69.0	35.9
19	39.8	37.5	35.0	83.2	55.0	45.2	35.8	48.8	35.4
20	53.7	42.1	29.0	39.0	42.0	37.9	33.3	71.8	31.2
21	47.0	34.0	11.2	23.4	54.7	41.8	26.6	34.1	18.9
22	42.1	34.6	24.2	49.0	44.8	36.8	26.5	48.7	25.3
23	40.1	34.2	26.3	57.7	43.3	38.4	32.9	67.2	29.6
24	34.5	33.5	32.2	91.5	40.0	35.8	30.7	69.7	31.5
25	35.0	33.0	30.4	83.2	44.2	36.5	26.6	50.0	28.5
26	37.6	32.0	23.8	57.3	52.2	41.0	27.9	39.4	25.8
27	40.0	35.9	31.0	70.4	53.9	43.2	32.0	43.5	31.5
28	31.9	30.0	27.2	82.7	50.0	43.1	36.3	59.7	31.8
29	31.2	30.3	29.0	91.5	46.8	38.9	29.6	51.5	29.3
30	37.0	31.6	23.6	58.2	30.0	28.1	25.2	81.8	24.4
31	15.0	15.0	15.0	100.0	46.0	34.4	15.8	29.4	15.4
Means	39.54	35.01	29.22	70.29	48.65	40.44	31.34	53.47	30.28
Normal	38.4	34.0	.....	.....	46.7	38.6	.....	.....	28.2

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TABLE X—Continued.

METEOROLOGICAL RECORD FOR OCTOBER, 1900.

Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
					7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
56.0	76.1	36.0	56.0	40.1	24.867	24.858	24.862	30.0	6.0
64.1	77.0	35.5	56.3	41.5	24.976	24.930	24.953	29.2	6.3
70.1	77.0	35.5	56.2	41.5	25.045	24.967	25.006	30.1	5.4
36.3	83.0	39.2	61.1	43.8	24.976	24.896	24.936	32.7	6.5
55.2	79.0	35.0	57.0	44.0	24.846	24.645	24.746	29.1	5.9
31.4	55.2	38.4	46.8	16.8	24.901	25.164	25.032	28.7	9.7
73.8	58.0	23.7	40.9	34.3	25.309	25.289	25.299	17.2	6.5
65.2	67.6	25.0	46.3	42.6	25.351	25.330	25.341	17.1	7.9
68.4	69.8	24.0	46.9	45.8	25.318	25.112	25.215	21.8	2.2
59.6	71.8	25.0	48.4	46.8	25.051	24.963	25.007	17.3	7.7
58.3	76.0	28.7	52.3	47.3	25.028	25.008	25.018	20.7	8.0
58.9	74.7	27.0	50.9	47.7	25.035	24.925	24.980	20.1	6.9
58.5	74.0	34.0	54.0	40.0	24.959	24.965	24.962	26.1	7.9
54.2	72.8	43.0	57.9	29.8	25.053	25.074	25.063	36.2	6.8
64.0	60.3	50.2	55.2	10.1	25.201	25.339	25.270	44.3	5.9
92.1	65.5	37.0	51.3	28.5	25.341	25.254	25.298	30.6	6.4
82.7	72.9	32.1	52.5	40.8	25.230	25.150	25.190	25.3	6.8
78.1	72.9	33.8	53.3	39.1	25.152	25.053	25.102	24.8	9.0
66.0	72.0	32.2	52.1	39.8	24.925	24.721	24.823	29.0	3.2
55.4	58.6	45.6	52.1	13.0	24.486	24.685	24.586	43.8	1.8
28.8	61.5	38.5	50.0	23.0	24.886	24.892	24.889	26.7	11.8
48.8	75.1	35.5	55.3	39.6	24.885	24.862	24.873	36.8	−1.3
62.5	61.9	35.3	48.6	26.6	25.010	25.128	25.069	29.1	6.2
80.6	62.0	32.3	47.2	29.7	25.049	24.924	24.987	27.1	5.2
66.6	59.1	31.5	45.3	27.6	25.117	*25.154	25.135	25.4	6.1
48.3	72.0	27.6	49.8	44.4	25.091	25.059	25.075	21.5	6.1
57.0	68.9	35.5	52.2	33.4	25.068	25.038	25.053	29.8	5.7
71.2	65.0	26.4	45.7	38.6	25.066	24.892	24.979	20.2	6.2
71.5	62.0	29.6	45.8	32.4	24.756	24.749	24.753	23.3	6.3
70.0	42.1	32.0	37.0	10.1	24.918	25.010	24.964	31.8	0.2
64.7	51.9	12.5	32.2	39.4	25.022	24.966	24.994	6.2	6.3
61.88	67.60	32.83	50.21	34.78	25.030	25.000	25.015	26.84	5.99
64.0	64.7	32.3	47.8	32.6	----------	----------	25.028	.....	6.0

* From Registering Aneroid Barometer.

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TABLE X—Concluded.

METEOROLOGICAL RECORD FOR OCTOBER, 1900.

	Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
	Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
			Ins.	Ins.			Miles	C°	C°	C°	Cal.	
1	....	....	....	....	0	NW	129.6	33.4	25.7	7.7	5.06	F
2	....	....	....	....	NW	NW	105.2	....	....	....	....	F
3	....	....	....	....	NE	N	144.5	49.6	33 0	16 6	11.94	F
4	....	....	....	....	S	SW	173.8	52.1	36.1	16.0	11.76	.....
5	....	....	....	....	NW	NW	313.2	51.3	35.2	16.1	11.75	F
6	....	....	....	....	W	NW	303.8	44.6	25.1	19.5	13.35	.....
7	....	....	....	....	N	NE	97.1	....	....	....	....	Hv F
8	....	....	....	....	SW	NW	82.3	45.1	26.7	18.4	12.70	Hv F
9	....	....	....	....	NW	NW	109.5	....	....	....	....	F
10	....	....	....	....	NW	NW	93.6	47.7	30.6	17.1	12 10	F
11	....	....	....	....	SE	SW	104.3	50.5	37.3	13.2	9.69	F
12	....	....	....	....	NW	NW	90.5	49.1	32.2	16.9	12.09	F
13	....	....	....	....	NW	N	95.1	41.0	28.2	12.8	8.74	.....
14	nt	....	T	....	SE	NE	122.3	....	....	....	....	.....
15	7.10 P	nt	.15*	....	N	E	111.9	13.5	11.1	2.4	1.38	.....
16	....	....	.09	....	N	NW	110.9	....	....	....	....	.....
17	....	....	....	....	NW	NE	90.6	....	....	....	....	.....
18	....	....	....	....	S	N	105.3	....	....	....	....	.....
19	....	....	....	....	NE	NE	121.5	....	....	....	....	.....
20	....	....	....	....	N	N	362.7	....	....	....	....	.....
21	....	....	....	....	NW	N	341.3	....	....	....	....	.....
22	....	....	....	....	SE	NW	117.1	48.6	32.0	16.6	11.85	F
23	....	....	....	....	N	S	143.4	....	....	....	....	.....
24	....	....	....	....	SW	W	148.5	....	....	....	....	.....
25	....	....	....	....	SW	N	134.0	....	....	....	....	.....
26	....	....	....	....	N	E	133.6	....	....	....	....	.....
27	....	....	....	....	SW	NW	119.9	....	....	....	....	.....
28	....	....	....	....	NW	NW	151.3	....	....	....	....	.....
29	....	....	....	....	NW	NW	204.5	....	....	....	....	.....
30	....	....	....	....	SE	0	158.0	....	....	....	....	.....
31	....	....	....	....	NW	W	136.5	....	....	....	....	.....
Means	....	....	0.24	....	....	....	150.2	43.88	29.43	14.44	10.20	.....
Normal	....	....	0.96	....	....	....	175.	....	....	....	....	.....

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* Rainfall also 10.00 A. M. ot 12:15 P. M., 15th.

TABLE XI.

METEOROLOGICAL RECORD FOR NOVEMBER, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Per ct.	F°	F°	F°	Per ct.	F°
1	26.8	24.0	18.8	71.0	42.0	34.1	22.7	46.3	20.7
2	29.0	26.1	21.0	71.9	43.0	36.1	27.3	53.8	24.2
3	52.5	38.0	16.7	24.0	43.8	34.0	19.0	36.7	17.8
4	32.5	26 8	16.3	50.3	42.0	32.0	14.9	33.0	15.6
5	24.9	21.5	14.3	63.3	46.0	33.8	13.0	26.1	13.7
6	31.2	25.7	15.0	50.4	46.8	34.2	12.8	25.2	13.9
7	33.0	27.2	16.7	50:1	34.7	29.8	22.1	59.5	19.4
8	25.5	23.9	21.0	82.6	27.0	24.7	20.5	76.2	20.7
9	32.3	29.3	24.7	73.5	42.3	33.9	21.6	43.4	23.2
10	22.6	20.8	17.2	78.9	32.3	24.7	7.4	34.4	12.3
11	16.2	14.0	7.8	69.4	33.5	25.0	4.9	29.4	6.3
12	20.3	17.1	8.7	60.4	58.8	43.2	24.9	27.1	16.8
13	33.3	26.8	14.3	44.9	33.9	28.6	19.7	55.4	17.0
14	18.3	17.8	16.7	93.4	44.2	34.3	19.3	36.6	18.0
15	27.1	26.0	24.2	88.5	30.8	29.6	27.9	88.6	26.1
16	30.6	29.2	27.2	86.7	37.8	31:7	22.6	53.8	24.9
17	29.0	26.5	22.3	75.6	32.0	28.1	21.7	65.3	22.0
18	11.0	10.9	10.6	98.3	22.9	20.8	16.5	75.7	13.5
19	17.8	17.3	16.2	93.4	21.0	19.0	14.5	75.6	15.4
20	14.8	14.8	14.8	100.0	14.8	14.2	12.6	91.1	13.7
21	17.6	16.9	15.3	90.6	53.9	39.1	18.2	24.5	16.7
22	52.8	39.2	20.8	28.6	35.0	31.0	25.2	67.2	23.0
23	30.8	28.1	23.9	75.0	42.0	32.7	17.9	37.3	20.9
24	32.7	23.7	—0.4	24.0	27.2	24.0	17.9	67.6	8.8
25	22.2	20.8	18.0	83.5	28.9	22.9	9.1	43.1	13.5
26	30.8	27.8	22.9	72.4	34.2	29.0	20.4	56.5	21.7
27	35.9	32.0	26.5	68.8	35.7	31.2	24.7	63.8	25.6
28	22.2	20.4	16.7	78.6	23.2	21.2	17.2	77.0	16.9
29	14.9	14.0	11.4	86.9	38.8	28.8	8.4	27.8	9.9
30	11.4	10.8	9.0	90.2	28.8	22.5	7.5	39.7	8.3
Means	26.67	23.25	16.95	70.84	35.91	29.14	17.75	51.26	17.35
Normal	25.4	22.6	.....	.....	33.8	28.2	.....	.....	18.1

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TABLE XI—Continued.

METEOROLOGICAL RECORD FOR NOVEMBER, 1900.

	Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
						7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
	Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
1	58.6	52.6	21.2	36.9	31.4	25.091	25.127	25.109	12.1	9.1
2	62.9	63.0	25.5	44.2	37.5	25.252	25.269	25.260	20.0	5.5
3	30.3	72.2	28.9	50.6	43.3	25.235	25.143	25.189	22.2	6.7
4	41.7	65.4	30.6	48.0	34.8	25.176	25.151	25.164	24.5	6.1
5	44.7	65.2	21.2	43.2	44.0	25.184	25.104	25.144	15.0	6.2
6	37.8	69.8	27.5	48.6	42.3	25.173	25.062	25.117	18.8	8.7
7	54.8	64.0	33.1	48.6	30.9	25.136	25.087	25.112	22.8	10.8
8	79.4	41.6	23.4	32.5	18.2	25.076	25.115	25.095	16.6	6.8
9	58.4	61.3	16.9	39.1	44.4	25.213	25.203	25.208	10.6	6.3
10	56.7	52.1	20.7	36.4	31.4	25.334	25.392	25.363	13.5	7.2
11	49.4	60.7	13.2	36.9	47.5	25.330	25.216	25.273	6.2	7.0
12	43.7	74.0	17.9	46.0	56.1	25.208	25.094	25.151	10.6	7.3
13	50.2	49.7	32.0	40.8	17.7	25.129	25.023	25.076	23.0	9.0
14	65.0	61.1	17.0	39.1	44.1	24.848	24.994	24.921	11.8	5.2
15	88.5	32.9	21.6	27.2	11.3	25.108	24.973	25.041	14.2	7.4
16	70.3	62.9	25.6	44.3	37.3	24.928	24.860	24.894	21.6	4.0
17	70.4	53.0	30.3	41.6	22.7	24.705	24.822	24.763	24.4	5.9
18	87.0	32.0	10.3	21.2	21.7	24.795	24.636	24.716	6.0	4.3
19	84.5	26.9	15.9	21.4	11.0	24.640	24.729	24.684	12.1	3.8
20	95.6	19.0	13.0	16.0	3.0	24.756	24.719	24.738	13.0	0.0
21	57.5	58.0	8.7	33.3	49.3	24.652	24.515	24.583	5.2	3.5
22	47.9	56.0	35.0	45.5	21.0	24.739	24.986	24.863	31.2	3.8
23	56.2	49.0	27.8	38.4	21.2	24.949	24.958	24.953	23.7	4.1
24	45.8	45.7	26.0	35.9	19.7	25.238	25.297	25.268	25.8	0.2
25	63.3	50.2	13.0	31.6	37.2	25.142	25.067	25.104	5.7	7.3
26	64.4	50.9	24.0	37.4	26.9	25.019	25.000	25.010	17.7	6.3
27	66.3	43.0	29.5	36.3	13.5	25.122	25.196	25.159	22.2	7.3
28	77.8	49.7	13.3	31.5	36.4	25.175	25.145	25.160	7.0	6.3
29	57.4	57.4	13.2	35.3	44.2	25.143	25.206	25.174	7.4	5.8
30	64.9	54.2	12.4	33.3	41.8	25.237	25.064	25.151	5.6	6.8
Means	61.05	53.12	21.62	37.37	31.39	25.058	25.038	25.048	15.68	5.94
Normal	67.5	50.6	20.9	35.0	30.2	.....	.....	25.005	.....	6.0

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TABLE XI—Concluded.

METEOROLOGICAL RECORD FOR NOVEMBER, 1900.

Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a m.	Actinomgter at Noon				Frost or Dew
Time o Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
		Ins.	Ins.			Miles	C°	C°	C°	Cal.	
.....	.....	.....	.....	SE	0	133.1	.....	.....	.....	.....	.....
.....	.....	.....	.....	W	NE	113.8	.....	.....	.....	.....	.....
.....	.....	.....	.....	NW	....	123.8	.....	.....	.....	.....	.....
.....	.....	.....	.....	E	N	130.9	.....	.....	.....	.....	.....
.....	.....	.....	.....	N	NE	154.8	.....	.....	.....	.....	.....
.....	.....	.....	.....	W	W	215.7	.....	.....	.....	.....	.....
.....	.....	.....	.....	SW	SW	170.8	.....	.....	.....	.....	.....
.....	.....	.....	.....	W	NW	84.5	19.4	9.5	9.9	5.79	.....
.....	.....	.....	.....	NW	W	137.1	43.5	26.1	17.4	11.95	F
.....	.....	.....	.....	SW	W	211.0	40.1	22.0	18.1	12.03	.....
.....	.....	.....	.....	NW	NW	101.8	.....	.....	.....	.....	.....
.....	.....	.....	.....	W	NW	219.2	48.0	30.9	17.1	12.13	.....
.....	.....	.....	.....	S	S	190.0	.....	.....	.....	.....	.....
.....	.....	.....	.....	N	NW	132.7	41.8	24.0	17.8	12.00	F
.....	.....	.....	.....	E	W	69.3	8.3	2.5	5.8	3.17	.....
.....	.....	.....	.....	SW	NW	133.3	45.0	27.8	17.2	11.91	.....
.....	.....	.....	.....	S	NE	136.5	.....	.....	.....	.....	.....
9:00 A	.....	T	.....	SE	SW	75.1	.....	.....	.....	.....	.....
6:55 P	.....	T	.....	SE	E	199.9	19.4	16.0	3.4	2.03	.....
nt	9:00 A	.07	1¼	E	SE	100.1	14.4	0.0	14.4	7.97	Sn
.....	.....	.....	.....	SE	SW	455.9	19.6	7.6	12.0	6.98	F
.....	.....	.....	.....	NW	SE	155.5	33.0	18.1	14.9	9.49	.....
PM	.....	T	.....	0	NW	296.7	19.4	11.3	8.1	4.77	.....
.....	.....	.....	.....	WNW	S	183.9	35.4	16.6	18.8	12.03	.....
.....	.....	.....	.....	N	NW	87.8	.....	.....	.....	.....	.....
.....	.....	.....	.....	W	N	106.1	9.9	6.8	3.1	1.73	.....
7:00 P	.....	T	.....	N	SW	172.4	17.2	10.0	7.2	4.19	.....
.....	.....	.....	.....	NW	NW	108.6	37.2	24.0	13.2	8.74	F
.....	.....	.....	.....	SE	SE	114.0	.....	.....	.....	.....	F
.....	.....	.....	.....	0	NW	181.2	.....	.....	.....	.....	F
.....	.....	0.07	1¼	....	....	156.5	28.23	15.82	12.40	7.93	.....
.....	.....	0.40	.....	....	....	184.0	.....	.....	.....	.....	.....

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TABLE XII.

METEOROLOGICAL RECORD FOR DECEMBER, 1900.

	Temperature, Dew Point and Relative Humidity								Daily Mean Dew Point
	7 A. M.				7 P. M.				
	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	Dry Bulb	Wet Bulb	Dew Point	Relative Humidity	
	F°	F°	F°	Perct.	F°	F°	F°	Perct.	F°
1	39.0	29.9	13.1	34.2	40.3	30.8	13.7	33.6	13.4
2	28.1	25.1	19 6	70.3	30.1	27.1	22.0	71.9	20.8
3	19.6	17.6	12.7	74.7	41.9	32.0	15.1	33.5	13.9
4	25.0	22.9	18.9	77.0	42.0	34.3	23.4	47.6	21.1
5	35.7	30.4	22.2	57.5	37.8	32.9	26.1	62.8	24.2
6	25.9	24.1	20.8	80.8	41.3	35.2	27.8	57.5	24.0
7	21.0	20.8	20.4	97.6	29.3	24.9	16.9	59.2	18.7
8	18.8	17.7	15.1	85.7	35.0	28.0	15.2	43.5	15.1
9	18.8	18.8	18.8	100.0	21.0	19.8	17.3	85.4	18.1
10	11.8	11.2	9.5	90.3	23.3	20.9	16.0	72.6	12.7
11	12.2	11.9	11.0	95.2	26.8	23.9	18.4	70.1	14.7
12	22.2	18.1	7.4	52.2	34.0	25.2	4.2	22.0	5.8
13	16 4	14.4	8.8	72.3	33.0	25.0	6.8	32.5	7.8
14	10.1	8.0	0.0	64.5	21.2	17.9	9.4	60.1	4.7
15	23.1	19.6	11.3	60.2	40.9	30 9	12.7	31.3	12.0
16	23.1	20.2	13.8	66.7	34.7	26.0	6.4	30.0	10.1
17	29.7	22.9	6.6	37 0	31.2	23.0	1.0	27.6	3.8
18	41.1	30.9	12.1	30.4	28.1	21.8	6.2	39.1	9.2
19	12.0	11.0	7.8	84.0	31.0	24.0	8.1	37.2	7.9
20	19.3	17.1	11.5	71.9	46.1	34.1	14.1	27.4	12.8
21	41.1	31.9	16.6	36.7	41.1	30.4	9.7	27.2	13.2
22	34.0	25.0	2.9	26.5	32.0	23.4	0.6	25.9	1.7
23	23.9	19.2	7.2	48.2	30.3	26.2	18.8	62.0	13.0
24	14.8	11.3	−1.0	49.6	30.9	27.5	21.8	68.7	10.4
25	27.0	24.7	20.5	76.3	26.4	22.6	14.8	60.9	17.7
26	15.9	14.6	11.1	81.6	32.0	25.8	13.4	42.5	12.2
27	26.2	23.9	19.6	75.7	20.2	17.9	12.3	71.4	16.0
28	−0.8	−0.8	−0.8	100.0	9.7	8.2	0.3	74.2	−0.2
29	3.2	2.4	−1.0	82.4	30.1	24.3	12.0	46.4	5.5
30	11.3	11.0	10.1	95.1	−7.6	−8.1	−11.3	82.5	−0.6
31	−21.8	−21.8	−21.8	100.0	−19.0	−19.0	−19.0	100.0	−20.4
Means	20.25	17.23	10.48	70.15	28.87	23.13	11.41	51.83	10.94
Normal	20.1	17.6	.....	.....	27.1	22.9	.....	.....	13.4

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TABLE XII—Continued.

METEOROLOGICAL RECORD FOR DECEMBER, 1900.

Daily Mean Relative Humidity	Maximum Temperature	Minimum Temperature	Daily Mean Temperature	Range	Barometer, Corrected for Temperature and Instrumental Error			Terrestrial Radiation	
					7 A. M.	7 P. M.	Mean	Instrument Reading	Radiation
Per ct.	F°	F°	F°	F°	Ins.	Ins.	Ins.	F°	F°
33.9	49.4	24.7	37.0	24.7	24.996	25.106	25.051	17.9	6.8
71.1	40.8	24.5	32.7	16.3	25.233	25.224	25.228	15.3	9.2
54.1	48.8	7.0	27.9	41.8	25.131	25.131	25.131	1.6	5.4
62.3	50.0	22.7	36.3	27.3	25.116	25.135	25.126	17.2	5.5
60.1	52.0	27.3	39.7	24.7	25.132	25.205	25.168	22.0	5.3
69.2	58.3	22.7	40.5	35.6	25.155	25.258	25.207	17.7	5.0
78.4	59.3	21.2	40.2	38.1	25.267	25.164	25.215	15.7	5.5
64.6	62.9	18.8	40.9	44.1	25.175	25.296	25.236	12.1	6.7
92.7	48.0	15.3	31.6	32.7	25.234	25.062	25.148	8.2	7.1
81.4	50.8	13.3	32.1	37.5	25.137	25.166	25.151	7.2	6.1
82.7	53.8	10.0	31.9	43.8	25.126	24.968	25.047	4.0	6.0
37.1	53.3	15.7	34.5	37.6	24.992	24.974	24.983	9.2	6.5
52.4	46.0	15.0	30.5	31.0	24.959	25.021	24.990	8.1	6.9
62.3	51.9	13.0	32.4	38.9	25.113	25.043	25.079	5.0	8.0
45.5	59.3	12.0	35.7	47.3	24.967	25.095	25.031	11.0	1.0
48.3	57.0	19.2	38.1	37.8	25.057	24.979	25.018	15.2	4.0
32.3	57.1	23.6	40.3	33.5	24.993	25.107	25.050	16.5	7.1
34.8	45.0	27.4	36.2	17.6	25.114	25.288	25.201	21.9	5.5
60.6	50.1	13.1	31.6	37.0	25.287	25.199	25.243	7.2	5.9
49.6	60.0	19.5	39.8	40.5	25.105	24.800	24.952	13.4	6.1
32.0	59.0	34.0	46.5	25.0	24.572	24.516	24.544	26.3	7.7
26.2	38.3	31.4	34.8	6.9	24.674	24.863	24.769	31.2	0.2
55.1	37.1	23.6	30.4	13.5	25.001	25.034	25.017	19.2	4.4
59.1	43.8	14.9	29.3	28.9	25.009	24.922	24.966	6.6	8.3
68.6	40.8	24.5	32.7	16.3	25.052	24.958	25.005	17.3	7.2
62.1	48.0	13.3	30.6	34.7	24.832	24.824	24.828	8.3	5.0
73.5	33.2	19.4	26.3	13.8	25.075	25.278	25.176	12.9	6.5
87.1	32.5	−3.3	14.6	35.8	25.257	25.012	25.135	−9.6	6.3
64.4	47.8	1.1	24.5	46.7	24.737	24.511	24.624	−5.7	6.8
88.8	*25.5	−7.0	9.2	32.5	24.768	24.901	24.834	−20.4	13.4
100.0	5.7	−22.0	−8.0	27.7	24.951	25.022	24.987	−30.6	8.6
60.99	47.27	16.00	31.64	31.28	25.039	25.034	25.037	9.74	6.26
69.8	44.1	15.3	29.3	28.8	.....	.....	24.975	.....	6.1

* From Self Register.

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TABLE XII—Concluded.

METEOROLOGICAL RECORD FOR DECEMBER, 1900.

	Precipitation				Direction of Wind		Total Movement 24 Hours following 7 a. m.	Actinometer at Noon				Frost or Dew
	Time of Beginning	Time of Ending	Total Amount Rain and Melted Snow	Average Depth of Snow	7 A.	7 P.		Black Bulb	Bright Bulb	Difference	Radiation	
			Ins.	Ins.			Miles	C°	C°	C°	Cal.	
1	....	....	....	....	NW	NW	353.2	36.2	19.8	16.4	10 65	.....
2	....	....	....	....	SW	N	144.3	....	....	....	....	L, F
3	....	....	....	....	E	NW	113.0	17 6	9.2	8 4	4.87	.....
4	....	....	....	....	W	S	112.0	20.6	15.0	5 6	3.36	.....
5	....	....	....	....	E	N	195.3	30.7	17 8	12.9	8.14	.....
6	....	....	....	....	NE	0	198.2	28.5	19.3	9.2	5.79	F
7	....	....	....	....	N	W	100.6	40.5	22.9	17.6	11 76	F
8	....	....	....	....	NW	W	121.7	42.7	25.6	17.1	11.64	.....
9	....	....	....	....	E	SW	80.7	....	....	....	....	F
10	....	....	....	....	SW	0	135.8	36.5	19.0	17.5	11.34	F
11	....	....	....	....	S	NW	120.5	38.0	19.8	18 2	11 90	F
12	....	....	....	....	S	NW	143.0	39.2	21 5	17.7	11.63	.....
13	....	....	....	....	W	W	103.2	....	....	....	....	.....
14	....	....	....	....	N	N	96.5	37.4	19 0	18.4	11 97	.....
15	....	....	....	....	W	W	187.1	24 5	15.5	9.0	5.49	.....
16	....	....	....	....	NE	W	115.2	....	....	....	....	F
17	....	....	....	....	W	S	196.9	41.8	19.6	22 2	14.73	.....
18	....	....	....	....	NW	N	273.3	33.9	17.0	16 9	10.76	.....
19	....	....	....	....	S	N	111.6	37.2	19 0	18.2	11.83	.....
20	....	....	....	....	W	NE	131.6	40.2	22.6	17.6	11.73	.....
21	....	....	....	....	SE	NW	583.8	42.0	24 2	17.8	12.02	.....
22	....	....	....	....	NW	NW	423.4	18.3	8.1	10.2	5.91	.....
23	....	....	....	....	NW	NW	319.9	....	....	....	....	.....
24	....	....	....	....	SW	NW	182.9	33 0	15.5	17.5	11.04	.....
25	....	....	....	....	NE	S	222.4	....	....	....	....	.....
26	nt	nt	....	....	NW	NE	254.9	37.5	19.0	18.5	12.04	.....
27	....	....	T	T	N	N	186.0	31.6	11.7	19.9	12.31	Sn
28	....	....	....	....	NW	NW	92.0	29.7	9.9	19 8	12.08	F
29	....	....	....	....	SW	NW	174.5	33 8	16.0	17.8	11.29	F
30	nt int	in d'y	0.11	1.8	N	0	162.2	....	....	....	....	Sn
31	....	....	....	....	NW	N	79.8	29.5	1.8	27.7	16.38	F
Means	....	....	0.11	1.8	....	....	184.4	33.37	17.03	16.34	10.44	.....
Normal	....	....	0.31	....	....	....	188.0	....	....	....	....	....

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TABLE XIII.

SUMMARY FOR AGRICULTURAL COLLEGE, FT. COLLINS, COLORADO.

Latitude, 40° 34'. Longitude, 105 W. from Greenwich. Elevation of Barometer, 4,994 feet; Ground, 4,980 feet.

FOR 1900.

MONTH	TEMPERATURE (In Degrees Fahrenheit)											No. Days		Precipitation (Inches)	Snowfall (Inches)	No. of Stormy Days	Relative Humidity, Mean	Dew Point, Mean	No. of Days Frost or Dew Was Observed	
	Mean (½ Max. and ½ Min.)	Average Maximum	Average Minimum	7 A. M.	7 P. M.	Absolute Maximum	Absolute Minimum	Mean Range	Greatest Range	Wet Bulb 7 A. M.	Wet Bulb 7 P. M.	Av. Temp. Below 32°	Minimum Below 32°						Frost	Dew
January	30.9	46.7	15.2	19.7	28.7	63.0	−6.0	31.4	45.0	17.9	24.6	14	31	0.25	3.1	3	73.3	15.5	16	0
February	24.2	37.8	10.7	15.3	23.6	58.0	−23.4	27.1	47.2	13.4	20.5	20	28	1.12	15.3	8	76.4	11.7	9	0
March	39.1	53.9	24.3	29.0	39.6	76.9	9.7	29.6	46.0	27.1	33.4	5	29	1.07	7.9	5	70.6	24.2	17	0
April	42.9	54.5	31.3	39.5	44.2	73.9	5.1	23.3	45.9	37.0	39.9	2	14	10.56	22.8	11	78.9	34.8	12	2
May	57.8	72.3	43.2	54.5	60.0	84.7	29.8	29.2	40.9	48.4	50.6	0	1	1.75	....	7	62.6	43.4	2	12
June	67.1	83.4	50.7	63.4	69.1	94.4	40.7	33.7	44.0	56.2	57.8	0	0	0.82	....	7	60.5	51.3	0	15
July	67.9	83.7	52.1	62.6	69.7	92.9	40.2	31.6	43.2	56.4	59.4	0	0	1.14	....	9	64.5	53.0	0	9
August	68.0	86.5	49.5	61.6	68.6	94.0	41.2	37.0	45.2	54.3	56.6	0	0	0.16	....	4	57.8	49.0	0	17
September	58.6	73.9	43.2	51.0	58.2	88.2	29.7	30.6	46.3	46.4	49.8	0	1	1.92	T	8	67.6	42.4	7	4
October	50.2	67.6	32.8	39.5	48.7	83.0	12.5	34.8	47.7	35.0	40.4	0	11	0.24	....	2	61.9	30.3	11	0
November	37.4	53.1	21.6	26.7	35.9	74.0	8.7	31.4	56.1	23.3	29.1	6	27	0.07	1.2	1	61.0	17.3	6	0
December	31.6	47.3	16.0	20.3	28.9	62.9	−22.0	31.3	47.3	17.2	23.1	13	30	0.11	1.8	1	61.0	10.9	10	0
Average	48.0	63.4	32.6	40.3	47.9	94.4	- 23.4	30.9	56.1	36.	40.4	60	172	19.21	52.1	66	66.3	32.0	90	59
Normal	46.5	62.2	31.7	39.5	46.7	....	.....	30.0	....	35.0	39.0	....	....	14.14	....	72.	65.1	30.2	.....	.....

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TABLE XIV.

SUMMARY FOR ARKANSAS VALLEY SUBSTATION, ROCKY FORD, COLORADO. H. H. GRIFFIN, Observer.

Latitude, 39° 3′. Longitude, 103° 45′. Elevation, 4,160 feet.

FOR 1900.

MONTH	TEMPERATURE (In Degrees Fahrenheit)											No. Days		Precipitation (Inches)	Snowfall (Inches)	No. of Stormy Days	Relative Humidity, Mean	Dew Point, Mean	No. Days Frost or Dew Was Observed		Prevailing Direction of Wind
	Mean	Average Maximum	Average Minimum	7 A. M.	7 P. M.	Absolute Maximum	Absolute Minimum	Mean Range	Greatest Range	Wet Bulb 7 A. M.	Wet Bulb 7 P. M.	Av. Temp. Below 32°	Minimum Below 32°						Frost	Dew	
January	34.5	48.8	20.2	23.7	32.6	67	2	28.6	56	22.3	29.3	9	31	T	T	0	77.9	21.6	....	....	W
February	30.8	47.4	14.3	18.7	29.9	67	−10	33.1	50	17.4	26.0	11	28	0.52	5.0	3	77.0	16.9	....	....	WNW
March	45.2	63.9	26.4	31.1	46.8	82	19	37.5	55	28.4	37.0	1	29	0.37	....	2	58.5	23.1	....	....	ENE
April	48.7	61.8	35.7	42.6	49.8	79	17	26.1	47	39.7	44.1	1	6	7.15	T	11	74.5	37.5	....	2	NW
May	61.7	76.5	46.9	55.4	62.3	90	38	29.6	39	50.9	54.1	0	0	2.28	....	7	69.7	47.8	....	9	N
June	72.0	88.8	55.1	65.4	73.0	101	48	33.6	46	59.6	61.5	0	0	1.47	....	5	64.0	55.7	....	19	E
July	74.4	90.8	58.0	66.4	74.0	103	52	32.8	47	59.8	61.2	0	0	1.77	....	6	60.7	54.8	....	15	NE
August	73.7	92.6	54.9	64.7	74.5	96	44	37.7	47	57.7	60.9	0	0	1.05	....	1	57.6	53.0	....	18	SW
September	65.2	81.6	48.7	55.8	65.2	95	30	32.9	55	50.0	54.7	0	1	0.08	....	2	61.6	45.9	1	2	E
October	55.7	73.9	37.4	45.5	55.4	88	26	36.5	52	39.7	44.9	0	8	0.60	....	4	56.5	33.3	1	....	W
November	4.07	59.3	22.0	27.6	37.9	77	9	37.3	57	24.7	31.4	3	27	0.06	0	1	63.2	19.8	....	....	NW
December	32.5	51.6	13.4	17.7	31.2	70	−21	38.2	57	11.6	25.5	10	30	0.24	3	2	63.5	12.0	....	....	WNW
Average	52.9	69.8	36.1	42.9	51.9	103	−21	33.7	57	38.5	43.6	35	160	15.59	8.0	44	65.7	35.0	....	....	.. ....
Normal	51.5	68.5	35.1	42.8	52.5	....	....	33.2	....	38.8	45.2	....	....	13.89	....	39.4	67.1	36.6	....	....	.....

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TABLE XV.

SUMMARY FOR PLAINS SUBSTATION, CHEYENNE WELLS, COLORADO. J. E. PAYNE, Observer.

Latitude, 38° 50'. Longitude, 102° 20'. Elevation, 4,278 feet.

FOR 1900.

MONTH	TEMPERATURE (In Degrees Fahrenheit)											No. Days		Precipitation (Inches)	Snowfall (Inches)	No. of Stormy Days	Relative Humidity, Mean	Dew Point, Mean	No. Days Frost or Dew Was Observed		Average Cloudiness	Prevailing Direction of Wind
	Mean (¼ Max. and ¼ Min.)	Average Maximum	Average Minimum	Wet Bulb 7 A. M.	Wet Bulb 7 P. M.	Absolute Maximum	Absolute Minimum	Mean Range	Greatest Range	7 A. M.	7 P. M.	Av. Temp. Below 32°	Minimum Below 32°						Frost	Dew		
January	34.5	47.9	21.4	25.6	32.0	63.2	—5.6	26.7	42.0	23.4	27.7	9	31	0.03	0.5	1	70.7	19.6	8	0	....	NW
February	28.6	42.3	14.8	19.7	24.2	62.0	—7.0	27.5	44.0	18.1	21.9	14	28	0.67	5.0	4	81.0	16.0	....	0	....	NW
March	41.2	56.4	26.1	32.4	39.1	83.0	14.0	30.3	50.0	29.5	33.2	4	23	0.56	3.0	3	68.4	24.7	1	1	....	W
April	48.4	59.2	37.6	43.8	46.9	79.0	20.0	21.6	41.0	40.9	42.8	1	4	9.95	4.0	8	79.9	38.5	....	....	....	E
May	60.1	74.1	46.1	58.1	59.9	87.0	38.0	27.9	38.0	51.7	52.2	0	0	0.80	....	4	66.5	46.6	0	3	....	SSE
June	70.7	85.0	56.4	66.7	70.9	98.0	49.0	28.6	36.0	59.5	60.8	0	0	2.47	....	5	64.7	55.1	0	4	....	S
July	74.2	88.9	59.5	70.0	74.8	100.0	51.0	29.5	41.0	61.4	60.1	0	0	2.02	....	5	56.0	53.6	....	....	....	S
August	75.2	91.8	58.6	70.2	75.7	100.0	45.0	33.3	44.0	61.1	59.9	0	0	0.30	....	2	52.4	52.8	....	....	....	SW
September	64.2	78.3	50.1	57.7	62.8	93.0	34.0	28.2	45.0	51.8	53.5	0	0	1.31	....	4	64.0	46.7	....	....	....	E
October	54.9	71.1	38.7	48.2	50.4	86.0	23.0	32.4	45.0	42.0	40.8	0	3	0.22	T	1	57.3	32.3	....	....	....	W
November	*43.9	*61.4	24.0	31.6	33.6	*76.0	12.0	*35.1	*46.0	27.5	28.3	....	24	T	T	0	64.0	19.1	4	....	2.9	W
December	*31.4	*47.1	18.1	24.0	27.6	66.0	-16.0	31.2	*41.0	21.3	24.0	....	30	0.18	2.0	1	69.5	16.1	....	....	2.6	NW
Average	52.3	67.0	37.6	45.7	49.8	100.0	-16.0	29.4	50.0	40.7	42.1	....	143	18.51	14.5	38	66.2	35.1	13	8	2.9	.....
Normal	50.4	65.3	35.5	44.7	49.1	....	....	29.7	....	39.7	41.7	....	....	16.13	....	43.1	67.2	34.5	....	....	....	.....

*Part of month.

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TABLE XVI.

SUMMARY AT CARLYLE LAMB'S, AT THE BASE OF LONG'S PEAK, ESTES PARK P. O., COLORADO.

Elevation, 9,000 feet, Approx.

FOR 1900.

MONTH	Mean Temperature	Average Maximum	Average Minimum	Absolute Maximum	Absolute Minimum	Mean Range	Greatest Range	No. of Days		Precipitation (Inches)	Snowfall (Inches)	No. of Stormy Days
								Average Below 32°	Minimum Below 32°			
January	25.8	38.6	12.9	53	−12	25.7	45	26	31	0.18	3.5	2
February	21.6	31.1	12.1	41	−9	19.0	40	26	28	0.82	14.5	4
March	30.6	42.0	19.3	60	8	22.7	33	20	28	0.35	5.5	4
April	31.6	43.4	19.7	63	−9	23.7	40	13	30	6.34	69.0	13
May	44.9	57.9	31.8	70	19	26.2	45	1	13	0.55	3.5	2
June	54.6	68.2	41.0	81	32	27.2	37	0	0	0.80	T	5
July	54.8	69.5	40.0	78	27	29.5	41	0	1	0.48	.....	5
August	56.2	71.2	41.3	79	33	29.9	41	0	0	0.17	.....	3
September	47.0	60.7	33.3	72	23	27.4	42	1	12	1.83	3.0	8
October	40.5	53.4	27.5	64	11	25.9	38	3	24	1.04	1.0	3
November	33.4	44.3	22.6	55	3	21.7	36	10	27	0.32	5.5	3
December	26.2	36.4	16.0	50	−27	20.4	46	19	31	0.62	9.0	4
Average	38.9	51.4	26.5	81	−27	24.9	46	119	225	13.50	114.5	56
Normal	37.6	49.8	25.5	....	.....	24.2	....	125	221	17.37	.....	66.7

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TABLE XVII.

SUMMARY AT GLENEYRE P. O., NEAR HEAD OF THE LARAMIE RIVER. MRS. F. W. SHERWOOD, Observer.
Elevation, 8,000 feet.

FOR 1900.

MONTH	Av. Temp. 7 A. M.	Av Temp. 2 P. M.	Av. Temp. 9 P. M.	Mean Temp. ½ (Max. + Min.)	Average Maximum	Average Minimum	Absolute Maximum	Absolute Minimum	Mean Range	Greatest Range	No. Days Av. Below 32°	Days Minimum Below 32°	Precipitation (Inches)	Snowfall	No. of Stormy Days
January	16.1	30.8	18.4	20.3	32.4	8.1	43	—17	24.3	39	29	31	1.20	12	5
February	13.7	27.9	16.5	17.9	29.8	6.0	42	—19	23.7	57	28	28	2.50	25	9
March	24.0	42.9	27.7	32.2	45.0	19.4	60	7	25.6	46	14	31	0.40	4	3
April	26.5	47.5	28.9	35.4	50.4	20.5	65	—12	29.9	55	8	30	0.55	55	12
May	43.0	66.2	40.7	50.5	68.5	32.5	85	21	35.9	54	0	10	0.30	.....	2
June	56.1	77.5	48.6	60.3	79.7	41.5	97	33	38.2	54	0	0	1.00	.....	6
July	55.8	80.0	53.2	62.1	82.8	41.3	95	33	41.5	56	0	0	1.60	.....	5
August	50.5	79.0	50.5	60.5	80.8	40.3	93	33	40.5	57	0	0	0.20	.....	2
September	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
October	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
November	25.1	43.7	27.6	33.5	46.7	30.3	68	3	26.4	44	12	27	T	2	2
December	17.5	33.8	20.6	22.9	35.1	10.7	55	—27	24.4	41	25	31	0.40	4	3
Average	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Normal	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

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TABLE XVIII.

SUMMARY AT MR. GEO. A. BARNES', PINKHAMPTON, NORTH PARK, COLORADO.

Elevation, 8,400 feet.

FOR 1900.

MONTH	Mean Temp. ½ (7 A.+7 P.)	Av. Temp. 7 A. M.	Av. Temp. 12 M.	Av. Temp. 7 P. M.	Highest	Lowest	Mean Range	Greatest Range	No. Days Av. Below 32°	No. Days Minimum Below 32°	Precipitation	Snowfall	No. of Stormy Days
January	22.9	36.1	9.7	.....	48	—19	26.4	48	25	28	1.00	10.0	6
February	22.8	33.1	12.5	.....	51	—23	20.6	48	23	27	3.00	30.0	10
March	35.4	49.3	21.5	.....	74	9	27.9	54	10	25	1.20	12.0	7
April	43.4	59.0	27.8	.....	78	2	31.2	58	3	13	4.65	46.5	12
May	52.4	67.0	37.7	.....	82	29	29.3	44	0	3	0.79	....	6
June	62.9	80.0	45.8	.....	94	37	34.2	48	0	0	0.85	....	3
July	63.5	81.1	46.0	.....	94	32	35.2	54	0	0	0.09	....	2
August	60.7	78.6	42.7	.....	88	34	35.9	50	0	0	0.43	....	6
September	54.6	71.3	37.9	.....	92	25	33.3	58	0	7	0.71	....	4
October	43.3	57.6	28.9	.....	69	14	28.7	46	3	19	0.69	....	4
November	34.0	45.8	22.2	.....	61	—2	23.6	48	8	23	0.84	....	2
December	22.2	33.6	10.8	.....	50	—30	22.8	54	24	31	0.80	8.0	5
Average	43.2	57.7	28.6	.....	94	—30	29.1	58	96	176	146.5	106.5	67
Normal	.....	.....	.....	.....	....	.....	.....	....	....	....	.....	....	.....

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TABLE XIX.

PRECIPITATION, 1900.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Pinkhampton	1.00	3.00	1.20	4.65	0.79	0.85	0.09	0.43	0.71	0.69	0.84	0.80	14.65
Lamb's	0.18	0.82	0.35	6.34	0.55	0.80	0.48	0.17	1.83	1.04	0.32	0.62	13.50
Shetland ranch	0.30	2.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Waterdale	0.19	0.86	0.97	9.21	1.76	0.45	1.05	0.57	1.72	0.18	0.12	0.22	17.30
Fort Collins	0.25	1.12	1.07	10.56	1.75	0.82	1.14	0.16	1.92	0.24	0.07	0.11	19.21
Rocky Ford	T	0.52	0.37	7.15	2.28	1.47	1.77	1.05	0.08	0.60	0.06	0.24	15.59
Cheyenne Wells	0.03	0.67	0.56	9.95	0.80	2.47	2.02	0.30	1.31	0.22	T	0.18	18.51
Gleneyre	1.20	2.50	0.40	4.40	0.20	1.00	1.60	0.20	.....	.....	T	0.40	.....

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TABLE XX.

WEEKLY MEANS OF SOIL TEMPERATURES, SET A, IN AN IRRIGATED PLAT NEAR THE COLLEGE BUILDING. (In Degrees Fahrenheit.)

FOR 1900.

WEEK ENDING	DEPTH					WEEK ENDING	DEPTH				
	3 in.	6 in.	1 ft.	2 ft.	3 ft.		3 in.	6 in.	1 ft.	2 ft.	3 ft.
Jan. 6	30.0	31.2	32.3	35.8	39.3	July 14	72.9	72.5	71.4	68.6	66.5
Jan. 13	29.7	30.9	32.0	35.3	38.7	July 21	70.5	70.7	70.3	68.7	67.2
Jan. 20	31.5	31.9	32.7	35.4	38.4	July 28	70.2	70.2	69.7	67.9	66.
Jan. 27	30.0	31.4	32.6	35.5	38.4	Aug. 4	71.6	71 3	70.6	68.3	67.0
Feb. 3	29.6	30.5	31.5	34.7	37.8	Aug. 11	71 0	70.8	70.2	68.5	67.4
Feb. 10	29.4	30.6	31.6	34.5	37.4	Aug. 18	69.0	69.3	68.9	67.9	67.2
Feb. 17	28.6	29.6	31.0	34.2	37.2	Aug. 25	67.7	68.7	69.1	68.2	67.6
Feb. 24	30.4	30.5	30.8	33.6	36.6	Sept. 1	67.1	67.4	67.4	66.8	66.6
Mar. 3	32.1	32.1	32.7	34.5	36.8	Sept. 8	65.9	66.6	66.9	66 6	66.4
Mar. 10	36.1	35.8	35.7	36.2	37.8	Sept. 15	64.5	65.6	66.2	63.8	61.2
Mar. 17	39.8	40.4	40.4	40.0	40.4	Sept. 22	58.0	59.8	61.7	63.6	64.7
Mar. 24	40.1	40.3	40.0	40.0	41.2	Sept. 29	54.0	55.9	57.9	60.7	62.4
Mar. 31	40.2	40.8	41.1	41.5	42.4	Oct. 6	52.8	54.2	55.7	57.7	59.7
Apr. 7	42.2	42.6	42.5	42.4	43.1	Oct. 13	48.6	50.5	52.5	55.7	58.0
Apr. 14	41.7	42.1	42.1	42.1	43.2	Oct. 20	51.8	52.8	53.9	55.3	57.0
Apr. 21	45.7	45.4	44.5	43.3	43.8	Oct. 27	49.0	50.5	52.1	54.3	56.3
Apr. 28	48.7	49.1	48.6	46.8	46.1	Nov. 3	45.4	47.5	49.5	52.5	54.8
May 5	49.5	49.3	48.5	47.2	47.2	Nov. 10	42.9	45.0	46.9	50.3	52.9
May 12	56.7	55.9	54.5	51.3	49.6	Nov. 17	40.2	42.3	44.1	47.8	50.8
May 19	57.1	57.0	56.4	54.2	52.4	Nov. 24	38.0	40.0	42.2	45.8	49 0
May 26	61.3	60.3	58.6	55.5	53.9	Dec. 1	36.6	38.5	40.4	44.1	47.3
June 2	67.3	66.3	64.2	59.7	56.9	Dec. 8	37.2	38.6	40.0	42.9	45.9
June 9	67.5	66.0	64.4	61.0	59.0	Dec. 15	33.0	35.3	37.2	41.5	44.9
June 16	65.6	65.6	64.7	62.0	60.2	Dec. 22	34.9	36.2	37.4	40.2	43.5
June 23	72.5	71.1	68.6	63.9	61.5	Dec. 29	31.8	34.0	36.0	39.7	42.9
June 30	72.7	72.2	70.8	66.9	64.5	Average	49.84	50.47	50.80	51.21	51.99
July 7	71.3	71.1	70.4	68.0	65.9						

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TABLE XXI.

WEEKLY READINGS (NOT AVERAGES) OF SOIL THERMOMETERS, SET C, ON UNIRRIGATED GROUND.

FOR 1900.

DATE	DEPTH				DATE	DEPTH			
	6 in.	1 ft.	2 ft.	3 ft.		6 in.	1 ft.	2 ft.	3 ft.
Jan. 4	30.4	30.7	34.3	36.6	June 28	71.5	67 8	62.9	59.2
Jan. 11	29.0	29.8	33.6	35.8	July 5	68.0	66.1	63.5	60.5
Jan. 18	30.9	31.1	33.7	35.5	July 12	71.5	68 2	64.6	61.3
Jan. 25	29.6	30.1	33.3	35.2	July 19	67.3	67.1	65.1	62.2
Feb. 1	28.2	28.5	32.0	34.2	July 26	69.2	66.7	64.4	62.0
Feb. 8	27.7	28.4	32.0	34.1	Aug. 4	71.4	68.5	65.7	62.9
Feb. 15	28.7	28.9	31.7	33.8	Aug. 9	71.4	68 7	66.1	63.3
Feb. 22	29.7	29.2	31.3	33.1	Aug. 16	70.0	67.7	65.9	63.5
Mar. 1	31.2	31.1	32.5	33.8	Aug. 23	68.4	66.7	66.0	63 8
Mar. 8	31.9	31.5	33.1	34.1	Sept. 1	70.7	68.1	66.0	63.8
Mar. 15	34.1	33.1	34.0	34.6	Sept. 13	66.6	65 2	65.4	63.9
Mar. 22	37.7	35.7	35.7	35.6	Sept. 20	60.7	60.0	62.1	61.8
Mar. 29	37.1	36.8	37.9	37.5	Sept. 27	52.1	54.4	59.3	59.8
Apr. 5	39.2	39.7	40.3	39.2	Oct. 4	55.8	54.4	56.3	57.0
Apr. 12	38.2	37.7	39.3	39.2	Oct. 11	51.6	50.9	54.2	55.4
Apr. 19	44.6	41.1	40.6	39.8	Nov. 8	43.0	44.4	48.6	50.3
Apr. 26	48.2	45.4	44.2	42.4	Nov. 15	40.1	41.3	45 8	48 1
May 3	50.1	47.5	44.7	43.4	Nov. 22	39.6	39.5	43 6	46.3
May 12	57.2	53.8	50.3	46.5	Nov. 28	37.2	38.2	42.7	44.9
May 17	56.7	54.3	51.5	48.8	Dec. 6	37.2	37 5	41.1	43 2
May 24	57.8	55.5	52.5	49.9	Dec. 13	32.9	34.4	39.3	41.9
June 1	62.2	59.7	56.3	52.8	Dec. 20	35.1	33 6	38.0	40.4
June 9	64.7	61.2	57.7	54.7	Dec. 27	32 9	33.6	37.4	39.7
June 14	63.1	60.4	58.2	55.4	Average	48.77	47.68	48.23	47.88
June 21	68.5	64.3	60.5	56.8					

This set of thermometers is placed on a knoll near the farm barn, unirrigated.

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TABLE XXII.

DATES OF EXTREME TEMPERATURES AT DIFFERENT DEPTHS FROM READINGS AT 7 A. M. AND 7 P. M. SET A.

YEAR	DEPTH											
	3 Inches				6 Inches				12 Inches			
	Date	Max.	Date	Min.	Date	Max.	Date	Min.	Date	Max	Date	Min.
1889	June 30	87.7	Jan. 9	16.0	July 1	81.2	Jan. 9	21.0	June 30	76.8	Jan. 21-22	26.0
1890	July 1	86.2	Jan. 2	14.5	July 1	81.2	Jan. 2	20.0	July 16	72.5	Jan. 24	25.5
1891	July 24	84.0	Feb. 9	17.8	July 11	80.6	Feb. 2	21.9				
1892	Aug. 24	84.2	Jan. 13	16.3	Aug. 14	80.8	Jan. 11	20.7	Aug. 15	72.5		
1893	June 28 to July 4	87.5	Jan. 18	21.3	July 5	83.9	Jan. 18	26.0	July 5	76.1	Jan. 21	30.3
1894	June 12	78.6	Dec. 28	14.7	July 27	76.1	Dec. 28	21.4	July 27	71.5	Dec. 28	24.3
1895	July 6	83.2	Jan. 15	8.5	July 6	78.8	Jan. 15	13.0	July 29	71.6	Jan. 15	19.2
1896	July 13	90.8	Jan. 4	18.8	July 13	86.1	Jan. 4	22.7	July 13	77.1	Jan. 4	27.9
1897	July 7	78.2	Jan. 5	18.9	Aug. 12	77.3	Jan. 5	23.9	Aug. 12	77.0	Jan. 5	29.5
1898	July 15	85.4	Dec. 14	20.0	July 17	82.2	Jan. 27 to Dec. 14	24.7	July 19	77.7	Jan. 27	28.0
1899	June 28	84.3	Jan. 10	18.8	June 28	79.2	Feb. 8	21.6	¶ July 24	73.9	Feb. 7	25.3
1900	June 23	84.3	Feb. 17	24.4	June 23	78.7	Feb. 17	26.6	Aug. 20	73.0	Feb. 18	28.7

¶ 74 June 29, after watering grass.

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TABLE XXII—Concluded.

DATES OF EXTREME TEMPERATURES AT DIFFERENT DEPTHS FROM READINGS AT 7 A. M. AND 7 P. M. SET A.

YEAR	DEPTH											
	2 Feet				3 Feet				6 Feet			
	Date	Max.	Date	Min.	Date	Max.	Date	Min.	Date	Max.	Date	Min.
1889	July 18	67.3	Jan. 28	30.9	Aug. 19	64.6	Jan. 29-31	33.3	Sept. 5-10	60.0	Mar. 3	39.2
1890	July 17-28 Aug. 7	66.9	Feb. 11	30.6	Aug. 21	64.6	Jan. 29	33.3	Sept. 1-12	60.0	Feb. 18	39.4
1891	July 26	68.7	Feb. 14-16-17	32.1	Aug. 16, 17 to Aug. 19, 20	65.6	Feb. 19, 22 to Feb. 23, 26	34.0	Sept. 17	63.8	Mar. 12-23	39.0
1892	Aug. 17	68.7	Jan. 24-25	31.4	Aug. 18	65.5	Feb. 28	33.6	Sept. 1	60.2	Feb. 24-26	39.6
1893	*July 6	75.3	Jan. 22	32.6	July 24	67.6	Jan. 23-27 to Feb. 11	34.8	†July 6	67.4	Feb. 21, 22-25	40.2
1894	June 28	69.8	Feb. 25	31.5	°June 28	69.7	Feb. 27-28	33.5	‖June 28	64.4	Mar. 15	38.5
1895	Aug. 2	68.0	Jan. 16	27.5	Aug. 7-8	65.9	Jan. 18	32.8	Aug. 30 to Sept. 19	61.0	Mar. 1	39.3
1896	Aug. 15-17	71.9	Jan. 6	31.6	Aug. 16-17	69.5	Jan. 8, 17, 18	35.5	Aug. 24-25	62.8	Feb. 17-22	41.0
1897	Aug. 12	§76.1	Feb. 2	32.4	§Aug. 17	73.6	Feb. 2-10	35.5	§Aug. 16	75.5	Mar. 24 to Apr. 2	41.0
1898	July 30	73.0	Jan. 28 to Feb. 12	33.0	Sept. 1	70.6	Feb. 7-20	36.5	Sept. 5-6	67.5	Apr. 10	43.4
1899	July 26-28	69.1	Feb. 15	30.9	July 28	67.2	Feb. 23 to Mar. 4	34.0	----------	----	----------	-----
1900	July 15	69.2	Feb. 19	33.1	Aug. 20	68.9	Feb. 19-24	36.5	----------	----	----------	-----

* Water applied to lawn, 69.2, July 31, was probably highest otherwise.
† Water applied to lawn, 62.6, September 11-13.
‡ July 31, 68.5, unaffected by water.
° August 22, 66.7.
‖ September 2, 62.5.
§ Affected by irrigation.
Observations made at 2 and 9 p. m. before July 1, 1889. Six-feet thermometer broken September 10, 1898.

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TABLE XXIII.

EVAPORATION FROM WATER SURFACE, TANK 3x3x3 FEET, FLUSH WITH GROUND, AT FT. COLLINS, COLORADO. (In Inches.)

Latitude, 40° 34'. Longitude, 105 + W. Elevation, 4.980 feet.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1887	2.46	3.23	4.60	5.55	5.19	5.75	5.23	4.24	4.12	3.26	1.48	1.60	46.71
1888	.....	.....	.....	.....	4.45	*7.70	*7.00	4.06	3.94	2.17	1.35	0.99	.....
1889	1.08	1.03	2.75	4.06	3.72	4.34	5.20	5.15	5 19	3.28	0.62	1.42	37.84
1890	0.86	2.36	3.58	3.50	4.32	5.71	5.44	5.76	3.69	2.71	1.32	1.10	40.25
1891	*1.89	1.90	2.23	2.24	5.03	4.97	5.72	4.91	4.12	3.62	1.74	0.75	39.12
1892	2.51	‡2.15	2.78	3.58	3.49	4.20	4.69	5.64	5.11	3.33	1.93	1.13	40.54
1893	¶	*1.52	3.79	5.40	5.12	6.12	6.41	4.73	5.04	3.79	1.05	1.88	.....
1894	†1.14	†1.15	1.95	4.61	4.66	5.01	5.74	4.88	3.77	3.75	1.64	1.22	39.52
1895	†1.19	†1.19	¶	4.91	4.27	4.13	4.57	4.52	4.06	2.24	1.53	1.68	.....
1896	2.64	2.25	2.39	4.71	5.91	5.09	5.23	5.80	3.34	2.94	1.62	1.25	43.17
1897	1.80	2.20	¶	3.33	4.13	4.26	4.64	4.76	3.97	2.88	1.47	0.94	.....
1898	1.12	*1.31	2.53	4.65	3.90	5.67	7.33	6.57	5.57	4.64	1.36	0.67	45.32
1899	‡1.51	‡1.39	‡1.54	3.79	5.35	6.37	5.38	5.86	5.04	2.87	1.86	1.15	42.11
1900	0.96	1.55	2.32	3.12	4.53	5.51	6.26	5.43	4.55	3.74	2.10	1.54	41.61
Average	1.43	1.79	2.77	4.07	4.58	5.35	5.63	5.17	4.39	3.23	1.51	1.24	41.16

*Based on record for part of month.
†From record of two months.
‡From record from February 17th.
¶ Tank punctured. Record lacking.
‡From record of three months.

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TABLE XXIV.

RAINFALL AT THE AGRICULTURAL COLLEGE, FT. COLLINS, COLORADO.

YEAR	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1872	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.02	0.20	.....
1873	0.25	0.16	0.00	1.20	2.30	1.50	1.30	0.85	0.75	0.42	0.20	0.17	9.10
1874	0.06	0.43	1.29	0.77	2.95	0.65	3.15	0.25	0.00	1.00	0.02	0.00	10.40
1879	.....	.....	.....	.....	.....	.....	.....	.....	.....	1.75	0.15	0.60	.....
1880	0.72	1.09	0.38	0.94	0.60	0.86	1.80	0.37	1.47	2.07	.....	0.10	.....
1881	1.10	0.55	1.45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1882	.....	.....	0.17	.....	4.67	3.07	1.76	0.89	2.51	0.82	0.29	.....	.....
1883	1.00	1.50	0.68	.....	2.51	3.18	.....	1.78	1.00	1.29	T	1.33	.....
1884	1.10	0.70	1.15	3.94	4.84	.....	.....	.....	.....	0.10	1.80	0.35	.....
1885	1.77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1886	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.69	1.18	0.33	.....
1887	0.86	0.23	0.25	1.10	1.23	1.96	3.05	2.12	0.54	0.43	0.15	0.00	12.12
1888	0.29	0.36	0.73	1.23	3.39	0.47	0.60	1.01	0.29	0.88	0.38	0.16	9.79
1889	0.21	0.34	0.65	2.07	3.39	2.06	0.79	0.95	0.42	3.16	0.43	0.01	14.48
1890	0.13	0.21	0.22	3.92	1.19	0.12	1.27	3.14	0.07	0.70	0.32	0.12	13.58
1891	2.32	0.16	1.21	2.14	4.07	1.30	0.17	2.05	1.01	0.20	0.60	0.46	15.69
1892	0.60	1.29	1.52	1.60	4.83	2.42	1.32	0.22	0.14	0.93	0.23	0.01	15.45
1893	0.02	0.54	0.14	1.66	1.92	0.26	0.64	0.92	0.18	0.16	0.55	0.12	7.11
1894	0.25	0.60	0.67	0.89	3.09	0.42	1.72	1.53	2.29	T	0.14	0.76	12.36

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TABLE XXIV—Concluded.

RAINFALL AT THE AGRICULTURAL COLLEGE, FT. COLLINS, COLORADO.

YEAR	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1895	0.24	1.52	0.54	1.36	3.62	3.65	3.75	1.45	0.47	1.06	0.40	0.01	18.07
1896	0.43	0.03	1.73	1.26	1.68	3.05	3.05	2.20	1.55	0.49	0.05	0.24	15.76
1897	0.18	0.54	2.15	1.39	2.06	1.69	2.65	1.74	0.75	0.75	0.67	0.67	15.24
1898	0.14	0.08	0.50	1.08	3.65	1.37	0.50	0.98	0.50	0.82	1.24	0.17	11.08
1899	0.66	1.04	1.50	1.10	1.01	1.03	4.95	0.99	0.21	3.23	T	0.47	16.19
1900	0.25	1.12	1.07	10.56	1.75	0.82	1.14	0.16	1.92	0.24	0.07	0.11	19.21
Normal	0.60	0.62	0.86	2.12	2.74	1.57	1.87	1.24	0.85	0.96	0.40	0.31	14.14

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